

MORPHOLOGICAL AND BIOLOGICAL NOTES ON
SOME SOUTH AFRICAN ARTHROPODS
ASSOCIATED WITH DECAYING ORGANIC MATTER

PART 3

THE FAMILIES DERMESTIDAE, CANTHARIDAE, MELYRIDAE,
TENEBRIONIDAE, AND SCARABAEIDAE (COLEOPTERA)

By

A. J. PRINS

South African Museum, Cape Town

(With 24 figures)

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ABSTRACT

The immature stages of twenty species of polyphagous beetles belonging to the series Bostrychiformia, Elateriformia, Cucujiformia and Scarabaeiformia were collected along a narrow strip between Mossel Bay and Elands Bay and in small areas around Laingsburg and Tulbagh. Their morphology is illustrated and their biology and association with decaying organic matter are noted. Observations on some families of minor importance are also included. Most of the species discussed are directly involved in the breakdown of organic matter.

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INTRODUCTION AND OBSERVATIONS ON MINOR FAMILIES

During the surveys of arthropods associated with decaying organic matter thirty-four species of beetles were collected in a narrow strip along the southern and western coastal regions of South Africa and also a small strip between Laingsburg and Beaufort West as well as between Worcester and Tulbagh. Fourteen species which are mostly predacious were discussed in the second part of this series; the immature stages of the remaining twenty polyphagous species belonging to the series Bostrychiformia, Elateriformia, Cucujiformia, and Scarabaeiformia are treated here.

The Scarabaeiformia include the coprophagous, phytophagous, myrmecophilous and termitophilous scarabs, the termitophilous valgines as well as the myrmecophilous clambids, and two other small families, the helodids and dascilids. The Elateriformia, Cucujiformia, and Bostrychiformia contain species of diverse habits and all have members that are of economic importance, being either entomophagous, phytophagous, xylophagous, or pests of stored products.

The curled-up scarabaeiform larvae of the cockchafers, dung-rollers, fruit-beetles and monkey-beetles are common in most soils containing plant roots or decaying organic matter. Predacious species, however, such as ladybirds and leather-winged or soldier-beetles (family Cantharidae) have caraboid or campodeiform larvae, whereas the eruciform types of the skin-and-hide beetles and those of melyrids and clerids are often found in dried vegetable or animal matter. The trogositids (family Trogositidae) (Fig. 13C), which are near the clerids as far as larval characters are concerned, are often attracted to carcasses and cadavers during the later post-mortem stages of decay, particularly after rains.

The adult beetles are very often gregarious or congregate in large numbers, such as the orange and black-coloured ladybird, *Lioadalia flavomaculata* (de Geer), of which vast numbers are occasionally found on fresh and semi-fresh kelp strings in the supratidal and also in the intertidal zones during the early summer. There is no explanation for this behaviour, but it perhaps coincides with

a shortage of its main food supply, aphids, at this time of the year, and they are then forced to search for new resources. Masses of dead and dying ladybirds, mainly the predacious *L. flavomaculata*, together with *Adonia variegata* (Goeze), *Cheilomenes lunata* (Fabricius), and *Scymnus moreletti* Mulsant, and various other beetles and stink-bugs are often found on the intertidal zone along the west coast. These insects have been blown out to sea by strong winds and are then washed on to the beaches.

Various beetles, some of which may be of economic importance, are attracted to dry or decaying organic matter; they may play an important role in the destruction of such material, or they may merely utilize it as shelter (e.g. under large dry cow-pats), particularly in open veld with little vegetation.

In the cases mentioned below, no morphological data on the larvae could be compiled. The adults of most of the species, however, were in some way associated with, or are related to, species attracted to organic matter.

Families Coccinellidae and Chrysomelidae

Apart from the above-mentioned ladybirds, another very small predacious species, *Cranophorus varius* Weise, which, according to collection data, is endemic to the Cape Province, was attracted to carcasses where a second and third sarcophagous stage occurred after repeated rains during the late autumn and early winter. It is about 1,9 mm long, shiny brown to piceous and covered with short fine hairs.

The adults of the phytophagous ladybird *Epilachna andulata* Thunberg, and of the red and black-striped leaf-eating beetle *Chrysomela fasciata* de Geer, are sometimes found to shelter under semi-dry cow-pats. Adults and larvae of both species feed on the leaves of plants of the daisy family (Compositae) (Skaife 1953). *C. fasciata* often causes extensive damage to foliage of *Arctotheca populi-folia* on the sand-dune system along the south-western coastal belt during late autumn and early winter. All the developmental stages of *E. andulata* may at times be collected on the same plant.

Pupae of another phytophagous ladybird, *Henosepilachna elaterii* (Rossi), were occasionally collected under semi-dry cow-pats along the coastal areas during autumn, together with adults of *E. andulata*. *Henosepilachna elaterii* were often associated with the black and orange-coloured *H. gibba* (Thunberg) in the Saldanha-Vredenburg area, also under cow-pats. The pupae of *H. elaterii* are yellowish with blackish spots, and the adult beetles, which emerged during March and April, are 5,8–8 mm long, cadmium yellow, with large oval black spots.

The larvae of some beetles such as certain halticids or flea-beetles (family Chrysomelidae) contain a toxalbumin, which may cause severe pain and even death in warm-blooded animals. Death by paralysis is apparently caused by a lethal saponin in the blood of the larvae of the bushman-poison beetles, *Diamphidia* and *Polyclada* spp. (Shaw *et al.* 1963). These are all yellowish beetles with larger or smaller blackish spots or marks on the elytra, and they vary from 10 to 15 mm in length. The larvae of the carabids of the genus *Lebistina*, particularly

L. peringueyi Liebke, *L. holubi* Peringuey, and *L. subcruciata* Fairmaire, which are ectoparasitic on the larvae of the above-mentioned poison-beetles, are even more poisonous than their hosts (Koch 1958). These carabids, about 15 mm in length, are also yellowish beetles, some with oblong blackish markings on their elytra. A few of these parasites and their hosts have been observed by the author under semi-dry animal droppings.

Families Elateridae and Anthicidae

Orthosomatic larvae are found in many families of which the adult beetles are associated with decaying organic matter; only in a few instances, however, have the larvae been observed in this medium. Certain click-beetles (Elateridae) such as *Lacon amplicollis* Boheman, a brownish to blackish species about 6,6 mm long, and some *Cardiophorus* spp. are often found in the veld under dry cow-pats which do not harbour carabids. Larvae of these beetles, also known as wire-worms, are elongate and cylindrical with a prognathous head, and may be predacious, phytophagous, and even luminous, as is the case with certain cantharids. Ant-beetles (Anthicidae) are common under dry cow-pats almost throughout the year, particularly the dull black *Anthicus stygius* la Ferté, and the larger shiny black *Formicomus caeruleus* (Thunberg) (about 4,2 mm long). Only one species, the shiny, dark-brown, wingless *Anthicus apterus* van Hille (Fig. 8M), was observed on carcasses during the ceratophagous stage of decay, but it was never seen on animal droppings in the veld.

Families Ptiliidae and Endomychidae

One of the most common beetles found in semi-fresh to almost dry dung is a black unidentified species of ptiliid, about 0,8 mm long. These insects, easily recognized by their feather-like wings, are some of the smallest of beetles known. Their campodeiform larvae resemble those of the rove-beetles in shape as well as in the pseudopodium-like tenth abdominal segment. They are active and are often found together with the adults even on compost heaps and decaying kelp on the beaches. According to Dybas (1976) the larval mouth-parts are not adapted for a carnivorous mode of life and they apparently feed on the organic matter and on fungus spores as in the case of *Mycetaea ovulum* Wollaston (Endomychidae). The latter is a small, oval, shiny brown fungus-beetle (about 1,3 mm long) often found in association with this feather-wing beetle, and which is, according to collection data, endemic to the Cape.

Family Cleridae

The chequered or clerid beetles are elongate, sombre coloured to metallic greenish or bluish or even brilliant red and yellow. Elytra are usually entire and tarsal formula is 5-5-5. The larvae are orthosomatic with a prognathous head; epicranial halves are separated by a gular area as in melyrids and the molar area of mandibles is lacking; dorsolateral glands are apparently absent in members of this family.

About 300 species have been recorded from the southern African subregion. Most of them are predacious in both the adult and larval form and are therefore beneficial; only three species, as far as is known, have become pests of stored products with a high fat content. Of these, two cosmopolitan species, the red-legged ham-beetle, *Necrobia rufipes* (de Geer), and the red-shouldered ham-beetle, *N. ruficollis* (Fabricius), occur in South Africa. Both these beetles are attracted to decaying carcasses of land and sea mammals and human corpses during the casein fermentation period. They are both long-lived and survived in the laboratory from March to January or February (a period of 10–12 months), copulation being observed during October. Simmons & Ellington (1925) give the longevity as 14 months. Larvae of both species were found to prey on the larvae of the skin-and-hide beetle *Dermestes maculatus* de Geer, and those of the cheese-skipper *Piophilha megastigmata* McAlpine.

Necrobia rufipes is a metallic greenish-blue beetle (4,4–6,6 mm long) with light reddish legs. The eggs are banana-shaped, yellowish white, and those collected on a decaying turtle measured 1,10 by 0,24 mm. The incubation period in the laboratory (25–26 °C) was 2–3 days and the life-span of five larvae occupied 90–272 days on dried beef, the pupal period being 9–13 days (21–25 °C). According to Simmons & Ellington (1925) the shortest developmental period is 30 days, which includes 17 days as growing larva and 13 days within the cocoon, until emergence of adult (daily mean temperature 24,4 °C).

Necrobia ruficollis, on the other hand, is somewhat smaller (4,5–5,5 mm long, blackish blue in colour with reddish pronotum and elytral shoulders, and also with reddish legs. Eggs are similar to those of *N. rufipes*; those collected on a seal carcass measured 0,88 by 0,28 mm. The incubation period in the laboratory (21–25 °C) was 2–5 days, the larval life-span being 104–203 days under similar conditions as those of *N. rufipes*. In both species a papery cocoon is produced by the larva in which pupation occurs. The pupal period occupied 9–14 days. Descriptions of the larva and pupa are given by Heeger (1848) and Scott (1919), and a general description of a clerid larva by Peterson (1967).

Both the above species as well as the smaller *Opetiopalpus collaris* Schönherr (3,6–4,4 mm) and *Corynetinus fimetarius* Wollaston (3,2–3,9 mm) have been collected under semi-dry to semi-fresh cow-pats on the beach and further inland. Both these latter species are blackish blue, the first with reddish and the second with bronzy pronotum.

In Cape Town at least four species of clerids have been recorded in timber, mostly *Eucalyptus* and kiaat, with the adult beetles feeding on the larvae of powder-post beetles (*Lyctus* species). The largest of these is *Cylidrus fasciatus* Castelnau (7,9–9,2 mm long), a somewhat shiny dark-brown beetle with a fairly broad yellowish transverse band across the middle of its almost impunctate elytra. It is widely spread in the Subsaharan and Malagasy regions (Corporaal 1950).

Paratillus carus (Newman), the white-banded clerid, which is of Australian origin, has piceous elytra with a very narrow whitish-yellow transverse band, the head and pronotum being reddish brown. It is slightly smaller than *C. fasciatus*

(5,3–6,1 mm long). Its adults are often observed in the Cape Town docks in Japanese oak, where it feeds on both adults and larvae of powder-post beetles. It has also been introduced into England (Winkler 1960). According to Fisher (1944) it is a common predator on *Lyctus* beetles and is also one of the most numerous and active predators upon larvae of the smaller timber-borers in Australia (Froggatt 1927).

Pallenis misella Boheman (4,9 mm long) is dark brown with a narrow yellowish transverse band over the punctate elytra, but it differs from the other three species in the pronotum, which is deeply and widely excised on each side of its posterior part. It is widely distributed in South Africa, including records from Natal.

The cosmopolitan small white-blotched clerid, *Tarsostenus univittatus* (Rossi), is of similar coloration to *P. misella*, but has a narrower yellowish transverse band on the punctate elytra and is smaller (3,2–4,6 mm long); it is widely distributed in South Africa as indicated by collection records from the Sandveld along the west coast and from Transvaal. According to Laing (1928) its adults appear at almost the same time as the adults of its host. Froggatt (1927) obtained this species from wood infested with larvae of *Heterobostrychus aequalis* Waterhouse.

A metallic-blue clerid *Cylidrus wallacei* Thomson, almost 12 mm long, was found in Bellville, Cape Province, during March 1983 in *Koompassia malaccensis* logs imported from Malaysia, and which were infested with larvae and adults of the yellow-legged auger-beetle, *Xylothrips flavipes* (Illiger) and the previously mentioned shot-hole borer, *Heterobostrychus aequalis*. Both bostrychids are widely distributed in the Far East (Froggatt 1927).

Trichodes aulicus Klug, another beautiful metallic-blue species about 8 mm long, but with three orange patches on the elytra, was bred during October from the nest of a small megachilid bee in the Calvinia district. According to collection data it is widely spread in the north-western Cape Province; otherwise its habits are unknown.

Families Colydiidae, Cucujidae and Ptinidae

The cylindrical bark-beetles (Colydiidae) and the flat-beetles (Cucujidae), particularly *Euxestus phalacroides* Wollaston and *Monotoma spinicollis* Aubé, which are common during the last or ceratophagous stage of decay of carcasses, were observed to be very numerous in dry cow-dung along the west coast of the Cape Province. They were found to feed on the dry particles and were often associated with the shiny black indigenous spider-beetle, *Pseudomezium coccureli* (Fairmaire), which is about 2 mm long. Both the first-mentioned colydiid and cucujid are widely distributed in South Africa and overseas (Hetschko 1930a, 1930b) and are small (1,9–2,3 mm long). *Euxestus phalacroides* is oval and shiny brown. *Monotoma spinicollis* is elongate and dull dark brown with serrate lateral prothoracic margins.

Spider-beetles (Ptinidae) are common in the dry decay stage of carcasses and

cadavers, and at least four cosmopolitan species occur in South Africa, of which *Mezium americanum* Castelnau and *Gibbium psylloides* (Czempinski) are almost glabrous and shiny. The latter, also known as the storehouse-beetle, usually occurs in ships carrying dried foodstuffs and is often reported as damaging maize kernels under such conditions. This species, together with the drugstore-beetle, *Stegobium paniceum* Linnaeus, and the tobacco-beetle, *Lasioderma serricorne* Fabricius, has been found in the tomb of Tutankhamun (Hinton 1945). The other two cosmopolitan ptnids, *Tipnus unicolor* (Piller & Mitterpacher), found in walnuts, and *Pseudoptinus lichenum* (Marsham), introduced from Europe, are hairy. Larvae of *P. lichenum* are known to bore in dry wood and bark of fig trees (Hinton 1941).

Another small, brown, hairy indigenous spider-beetle, *Stethomezium squamosum* Hinton, was found in the roots of the shrub *Maerua racemulosa*, which are eaten by the local people during food shortage; this shrub occurs from the eastern Cape Province to Swaziland. Hinton (1943) also records *Ptinus tectus* Boieldieu together with other beetles in the roots of this plant, as well as *Mezium natalense* Peringuey breeding in blood-meal in Zimbabwe. A rather small, unidentified, shiny-brown *Meziomorphum* sp. covered with fairly long spinose hairs and which is about 1,9 mm long, has been observed to feed on owl pellets in the vicinity of Cape Town.

Family Nitidulidae

Various undetermined sap-feeding beetles often appear on decaying animal matter, mostly on carcasses during the late dermatophagous and early ceratophagous stages of decay. Two well-known members of this family, the dried-fruit beetle, *Carpophilus hemipterus* (Linnaeus) and the corn-sap beetle, *C. dimidiatus* (Fabricius), are, according to collection data, widespread in South Africa. *Carpophilus hemipterus* is dark brown with large brownish-yellow marks on the elytra and was common in soil where fish-meal was used as fertilizer, together with *C. humeralis* (Fabricius), which is piceous brown with a small yellowish-red spot on the base of each elytron; this latter species is also widespread in South Africa. *Carpophilus dimidiatus* is a reddish-brown species, often found in dried figs. These are all small beetles varying in length from 2,3 to 3,5 mm.

A larger (about 4,8 mm long) and more robust dark-brown species, *Aethina castanescens* (Fairmaire), was common in chicken manure in fowl pens in the Cape Peninsula, together with larvae of house-flies, false stable-flies and lesser house-flies, and the millepede *Ommatoiulus moreleti* (Lucas), but it was absent in manure which harboured large populations of the lesser meal-worm *Alphitobius diaperinus* (Panzer), and the skin-and-hide beetle *Dermestes maculatus* de Geer.

Families Cerambycidae and Curculionidae

Apodous larvae are found among long-horned and snout-beetles. In the long-horned beetles (Cerambycidae) the larvae are elongate and somewhat

depressed. In the snout-beetles (Curculionidae), however, they are C-shaped and usually have a hypognathous head. Larvae of long-horned beetles live in wood and some are well-known pests. The adults, however, feed on flowers, leaves, and bark or pollen of plants, and only one species belonging to the genus *Stenauxa* was sometimes found among leaf litter and debris on the sand-dune system of the coastal belt, together with the coppery oedemerid, *Melananthus senex* Blair.

Adult snout-beetles, on the other hand, were common under cow-pats as well as in leaf litter throughout the entire survey area, and were represented by at least five subfamilies, of which the Eremninae predominated. At least three well-known *Eremnus* species (Fig. 1D), viz. *E. cerealis* Marshall, *E. setulosus* Boheman and *E. atratus* (Sparrman) (all endemic to the Cape Province according to collection data) were found to be plentiful under dry pats, mainly in the western Cape Province during the summer and autumn. Both *E. cerealis* (speckled snout-beetle or grain-worm) and *E. setulosus* (grey snout-beetle) were mostly observed under pats in fallow land and were collected only occasionally in the veld. *Eremnus atratus* was also found at Hermanus during midwinter. *Eremnus pilosus* Boheman, which resembles *E. setulosus* but is smaller, seems to be restricted to the south-west of the Cape Province and was prevalent throughout the spring. A small dark-brown *Eremnus* sp., about 4,5 mm long, was very common near Saldanha Bay and Paternoster, but was never collected in any other area.

The vegetable-weevil, *Listroderes costirostris* Schönherr, and *Neocleonus sannio* (Herbst) (Fig. 1A) (both widely distributed in South Africa and overseas (Csiki 1934, Voss 1973)), as well as *Rhytirrhinus inaequalis* (Fabricius) (Fig. 1C), which is endemic to the Cape Province, according to collection data, were mostly found under dry cow-pats in the southern Karoo during the summer. However, *N. sannio* was often found along the west coast under similar conditions, together with *Rhytirrhinus acerbus* Boheman. During the late summer and early autumn very large numbers of the vegetable-weevil, *L. costirostris*, may be present under totally dry cow-pats in the sandveld area along the Cape west coast, particularly during periods of drought. In certain areas up to three hundred specimens were counted under a single large pat. *Rhytirrhinus* and *Listroderes* are more or less the same size (7,5–7,8 mm long), but these two species of *Rhytirrhinus* are easily distinguished by the strong carinae on the elytra. *Neocleonus sannio* is much larger (12–13 mm), light grey in colour and marked with four to six brown patches on the elytra.

A tiny, dull-black species of *Ocladius*, about 3,7 mm long and almost globular in shape, with rugosoreticulate elytra and the pronotum with rows of parallel, longitudinal, thin carinae connected with cross-ridges, was found under dry pats in the Karoo during the late summer and autumn. At least one species of *Rhysoderes* (Fig. 1B) was found to shelter under cow-pats near Saldanha. It is 6,6–8,0 mm long, brownish grey, with head and pronotum rugosopunctate.

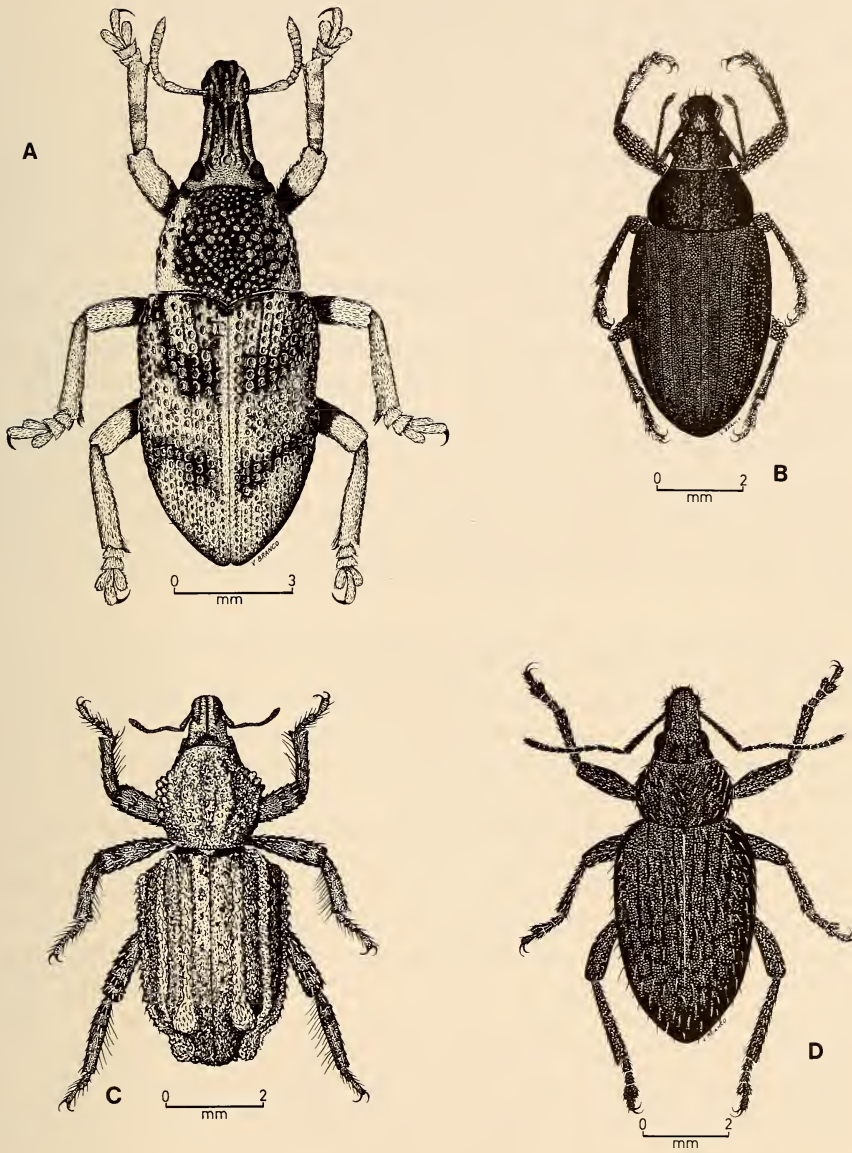


Fig. 1. Curculionidae. A. *Neocleonus sannio*. B. *Rhysoderes* sp. C. *Rhytirrhinus inaequalis*. D. *Eremnus* sp.

MORPHOLOGICAL DESCRIPTIONS AND BIOLOGICAL NOTES

The systematic arrangement followed is that of Britton (1970).

SERIES BOSTRYCHIFORMIA

Family **Dermestidae**

Small to medium-sized oval to somewhat elongate beetles, usually of sombre coloration, often with coloured pattern due to the arrangement of scales on the body. Head small and deflexed with clubbed antennae. Hind wings well developed, elytra covering the abdominal segments. Tarsal formula 5-5-5.

Of the nearly 500 species described, only about forty have been recorded from southern Africa, of which at least ten species are of economic importance. Hinton (1945) gives a good account (including illustrations) of the various species. Dermestids are scavengers and feed on dried animal and vegetable matter with a high protein content, and some species are therefore attracted to decaying organic matter such as carcasses or cadavers, particularly during the formation of butyric acid and other volatile fatty acids. Many species are found in nests of insects and other higher animals, including birds and small mammals, often killing the young, and a few are even predacious, feeding on the immature stages of other insects such as the larvae of the wax-moth, *Galleria mellonella* Linnaeus, in beehives.

Apart from the fact that the hairy larvae may cause dermatitis in sensitive people, due to the liberation of histamine stimulated by urticating hairs (Smith 1973), there is also the danger of diseases such as anthrax (*Bacillus anthracis* Koch) being spread by these beetles. The hairs of some species may remain in the grain on which the larvae were feeding and may have serious effects when swallowed (Morison 1925).

The larvae are easily recognized by their long body hairs, which may be simple or modified, and members of the genus *Dermestes* have, in addition, paired sclerotized urogomphi. They do extensive damage to stored foodstuffs (grain and cereal products, dried fish, bacon, biltong, dried sausages, ham, etc.), carpets, leather, feathers and hair, beeswax, clothes, skin and hides, bone, insulating materials and museum specimens. Larvae and adults recovered from Egyptian mummies had caused considerable damage to the embalmed bodies (Strong 1981). At least eleven species of beetles were found in the skull of an Egyptian mummy (Hope 1834), of which four were skin-and-hide beetles, viz. *Dermestes maculatus* de Geer, *D. peruvianus* Castelnau, *D. frischii* Kugelann, and *D. roei* Hope. Dermestid larvae will attack laminated boards or even plaster-of-paris models if they contain glue of animal or vegetable origin, and when ready for pupation they will perforate roof timbers, wooden panels, and even lead sheeting. Under adverse conditions they may turn cannibalistic.

There are at least three vegetarian species of *Trogoderma*, of which the well-known cosmopolitan Khapra beetle *T. granarium* Everts, is the most important. It is a serious pest of stored grain elsewhere in the world, but is apparently not

established in South Africa. However, it was reported from a brewery in Pietermaritzburg in malt imported from England as early as 1953, and from near Pretoria in 1955 when a heavy infestation of this beetle and some other grain insects occurred in a store in sweepings that had been allowed to accumulate for about three years.

The carpet-beetles include at least six cosmopolitan or nearly cosmopolitan species that have been recorded from South Africa, including the widely distributed varied carpet-beetle, *Anthrenus verbasci* (Linnaeus), also known as the museum-beetle, which is so destructive to dried museum specimens, and the true museum-beetle, *A. museorum* (Linnaeus), reported in the past only from South West Africa. The furniture carpet-beetle, *A. vorax* Waterhouse, which is very similar to *A. verbasci*, but is easily separated from the latter by the inner or mesal margin of the eyes, which is excised or interrupted in the middle (entire in *A. verbasci*), has been observed in nests of the social weaver-bird (*Philetairus socius* (Latham)). The larvae feed on feathers and other debris. One of the more common species found in carpets, bird carcasses and poultry manure in the western Cape Province is the cosmopolitan black carpet-beetle, *Attagenus piceus* (Olivier), which is more elongate than species of *Anthrenus*; it is occasionally found in association with the indigenous *Attagenus jucundus* Peringuey and the nearly cosmopolitan *A. gloriosae* (Fabricius) in carpets in the Cape Peninsula.

Skin-and-hide beetles are common in decaying carcasses, both on the beach and inland, in fish-meal, dried fruits, animal droppings, and even horn, feathers, and biscuits. Four cosmopolitan species are recorded from South Africa, of which *Dermestes maculatus* and *D. peruvianus* are the most numerous in the western Cape. *Dermestes ater* de Geer, although widespread, is a more northern species, whereas the larder-beetle, *D. lardarius* Linnaeus, is only found occasionally in the Cape Town docks, mostly in dried foodstuffs such as macaroni and walnuts.

Dermestes maculatus de Geer

DESCRIPTION

Adult

Previously described by Hinton (1945). Blackish, dorsally clothed with decumbent fulvous to greyish hairs, with mostly head and a broad band along each lateral margin of pronotum covered with longish white hairs. Apex of each elytron serrate and sutural angle produced in form of a strong tooth, absent in the other two species described here. Lateral impressed line of first sternite curved inwards near base. Length of specimens examined varying from 5,5 to 10 mm.

A native of Europe and widely spread in most parts of the world (Hinton 1945). It is the most common skin-beetle around Cape Town and is also well established on most of the islands along the South African south and west coasts, including Dyer, Bird, Marcus, Jutten, Ichaboe, and Malgas islands.

Larva (Fig. 2A)

General descriptions are given by Rees (1943), Hinton (1945), and Peterson (1967). Body form of *Dermestes maculatus* larva elongate, semi-circular; tergites sclerotized and piceous to dark brown with broad, pale yellowish-white median, longitudinal line over dorsum, representing ecdysial suture. Head hypognathous. Tergal plates covered with medium-long to very long spinulate setae, some hairs on third to eighth abdominal segments somewhat longer than others. Spinulate hairs on ventral side paler and shorter. Integument smooth, without spinules except for short branched (spinulate) spines on certain areas. A transverse row of strong pointed tubercles present on anterior margin of dorsal sclerotized plates of abdominal segments 4–9 (Fig. 5A–B). Spiracles well developed, mesothoracic one the largest, oval (Fig. 2C); first three abdominal spiracles less oval and situated on a non-sclerotized membrane below sclerotized tergal plates, those on fourth to eighth segment smaller than other abdominal spiracles, almost circular and situated on the sclerotized tergal plates (Fig. 5A); in pale-coloured larvae they are often less sclerotized than others (Fig. 2D). Legs pale brownish to brown, tarsungulus (Fig. 3L) dark brown, and with short narrow keel-like projection ventrally on each side of which is a long fine seta. Setation of posterior face of tibia as in Figure 3L; characteristic of *D. maculatus* is the long fine posterodorsal preapical seta on tibiae. Length of full-grown larva about 15 mm.

Head (Fig. 2E–G)

About as wide as long, or only slightly wider than long, sides and hind margin dorsally fairly convex. Frontal and epicranial (coronal) sutures distinct; frons strongly sclerotized except for narrow strip along anterior border and on each side in front of antennae; each side of frons with strong conical tubercle. Epicranium also strongly sclerotized, except for small area around ocelli; latter six in number, on each side arranged in two almost vertical parallel rows. Setation more or less as illustrated. Antennae (Fig. 2B) three-segmented with whitish cone-shaped basal articulating membrane; first segment slightly more than half the length of second, wider than others; with about six setae situated dorsally some distance from its apex; second segment with sensory appendix (sensory cone) at apex and an oval sensory spot near middle. Third segment small, about one-third the length of second, with sensory pegs at apex.

Labrum and clypeus

Labrum slightly more than half the length of clypeus, narrower than latter, its anterior margin fairly deeply and angularly excised in middle. Clypeus trapezoidal, much narrower in front than behind; anterior margin slightly concave, preclypeus without setae, except for medium-long seta on each side near lateral margin; postclypeus with about six to eight medium-long setae.

Epipharynx (Fig. 2H) with proximal sensory area composed of about six large and ten small sensory papillae arranged in two almost parallel rows. Epipharyngeal scleromes parallel, tapering and somewhat diverging posteriorly.

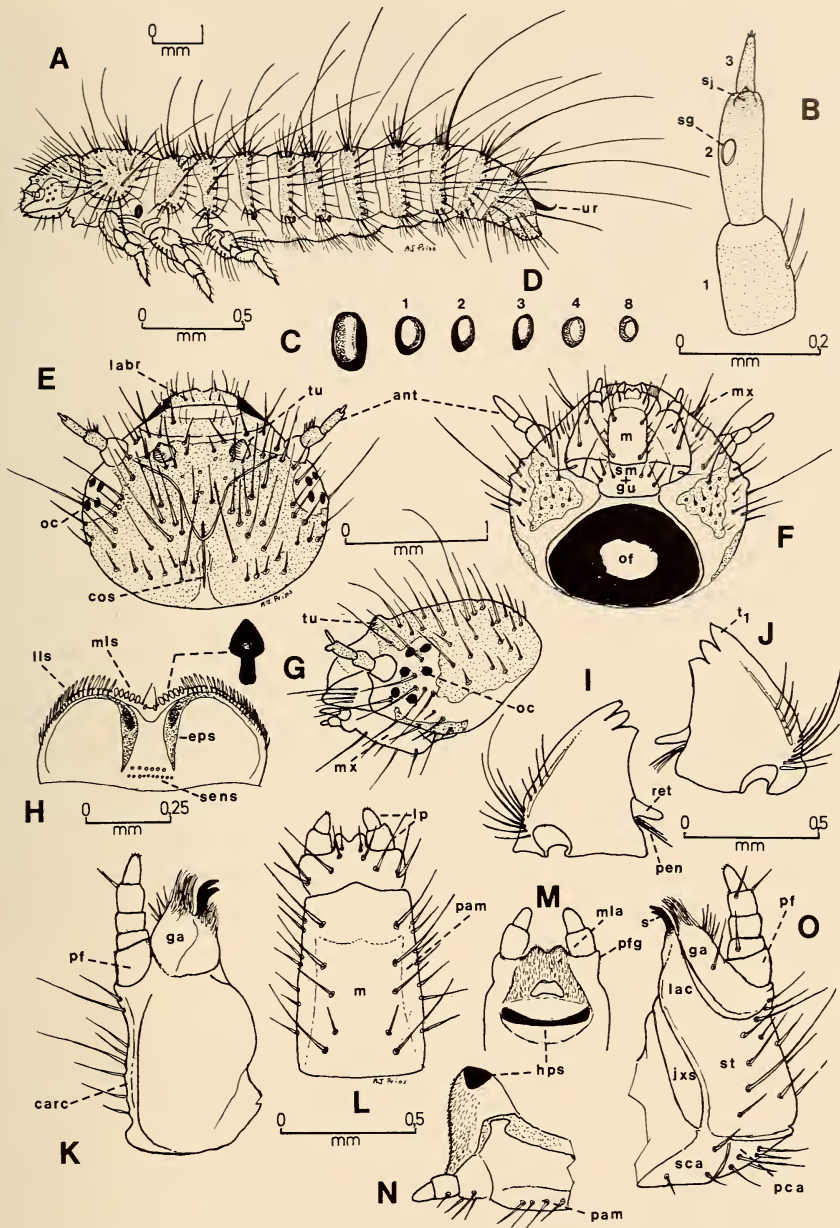


Fig. 2. Dermestidae. *Dermestes maculatus* larva. A. Full-grown, left lateral view. B. Antenna. C. Mesothoracic spiracle. D. Abdominal spiracles, segments 1-3, 4, 8. E. Head, dorsal view. F. Head, ventral view. G. Head, left lateral view. H. Epipharynx. I. Left mandible, dorsal view. J. Right mandible, dorsal view. K. Left maxilla, dorsal view. L. Labium, ventral view. M. Labium, dorsal view. N. Labium, left lateral view. O. Left maxilla, ventral view.

Broad median lobe setae about five in number on each side, lateral lobe setae longer and finer and covering each lateral margin to a point well beyond its middle. Also two sensory pegs situated in median V-shaped excision below two dorsal median setae.

Mandibles (Fig. 2I–J)

Broad, almost triangular and slightly less than one-third the length of head. Cutting edge tri-dentate, apical tooth (t_1) somewhat larger than others. Molar area absent, but represented by large stiff process of retinaculum and brush of hairs or penicillus. Lateral face with demi-scribe with about four setae of which the distal two are longer than others; also transverse row of hairs near base of mandible on lateral face, with median hairs the longest.

Maxillae (Fig. 2K, O)

Galea and lacinia united, only free at extreme apex, the boundary lines clearly indicated on both sides. Lacinia with forked spur at apex and dorsally also with brush of fine fulvous hairs, otherwise devoid of setae. Galea lobe-like with brush of fine fulvous hairs apically and four to five short setae on external lateral margin just below brush of hairs, as well as one somewhat longer seta on ventral side near palpifer. Stipes broad, almost quadrate with some setae on ventral side of which one is much longer than rest; dorsally without setae; also some medium-long setae along its ridge-like exterolateral margin. A narrow juxtastipes present, demarcated by sclerotized margin of stipes. Palpifer without setae. Maxillary palp four-segmented, the segments somewhat tapering towards apex; first and second segments of about equal length and somewhat shorter than third and fourth in specimens examined; first segment with a single ventral seta, the penultimate one with two setae, one lateral and one ventral; apical segment with some sensory pegs at apex. Subcardo and precardo (alacardo) clearly indicated by sclerotized demarcation line; former with only about three, latter with about seven setae.

Labium (Fig. 2L–N)

Submentum and gula fused, mentum almost rectangular, longer than wide with setal pattern as indicated in figure, including longitudinal row of setae on lateral face (paramentum). Ligula cleft in middle, ventrally with about five setae on each lobe as indicated; hypopharyngeal sclerome as a curved sclerite and raised above the palpi in all specimens examined, superlinguae beset with minute setae. Labial palpi two-segmented, tapering towards apex, segments of about equal length, without setae except for sensory pegs on apical one.

Pupa (Fig. 3A–B, E–G, J)

Somewhat elongate, about two and a half times longer than wide when seen from above, creamy white in colour; completely covered with fine medium-long fulvous hairs, each hair growing from a small rounded tubercle, which is coloured

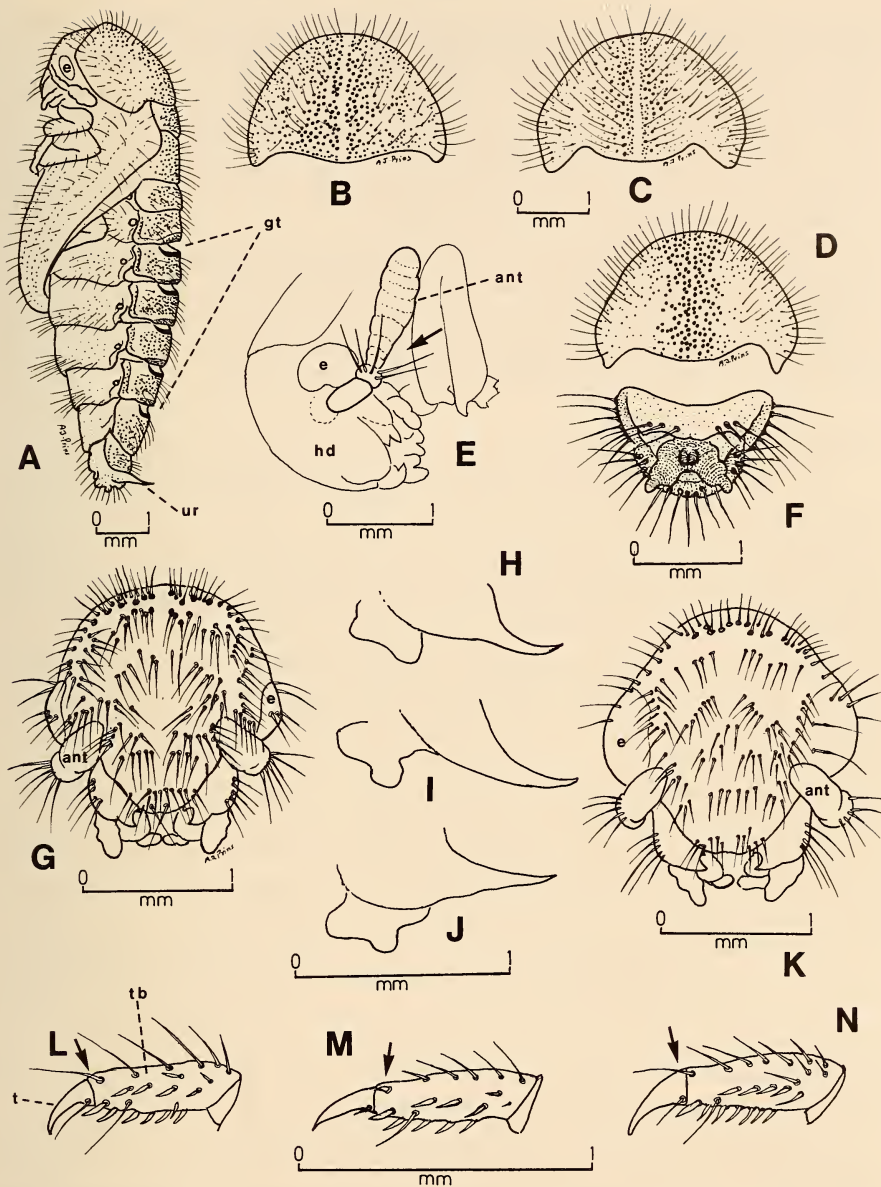


Fig. 3. Dermestidae. A. *Dermestes maculatus* pupa, left lateral view. B. *Dermestes maculatus* pupa, pronotum, dorsal view. C. *Dermestes ater* pupa, pronotum, dorsal view. D. *Dermestes peruvianus* pupa, pronotum, dorsal view. E. *Dermestes maculatus*, antenna of pupa, left lateral view. F. *Dermestes maculatus*, abdominal apex of pupa showing developing genital capsule, ventral view. G. *Dermestes maculatus*, head of pupa, dorsal view. H. *Dermestes peruvianus*, urogomphus of pupa, left lateral view. I. *Dermestes ater*, urogomphus of pupa, left lateral view. J. *Dermestes maculatus*, urogomphus of pupa, left lateral view. K. *Dermestes peruvianus*, head of pupa, dorsal view. L. *Dermestes maculatus*, tarsungulus and tibia of left front leg of larva, posterior view. M. *Dermestes ater*, tarsungulus and tibia of left front leg of larva, posterior view. N. *Dermestes peruvianus*, tarsungulus and tibia of left front leg of larva, posterior view.

yellowish red; tubercles and their coloration more prominent on median dorsal side of pupa, particularly in newly formed pupae; those on pronotal disc somewhat larger than others. The five so-called 'gin-traps' on third to seventh abdominal terga coloured reddish and very distinct, even in old pupae. Spiracles large, almost circular on abdominal segments 1-6, that on seventh smaller and less obvious. Two urogomphi vertical and almost parallel. Developing genital capsule in form of two swellings as indicated in figure.

Characteristic of the pupae of all three species of skin-and-hide beetles examined are the six to ten setae on the second ringlike segment of the antennal sheath (Fig. 3E). These setae are also present in the pupae of *Attagenus piceus*, in which case there are six 'gin-traps'. In all the pupae of *Anthrenus verbasci* that were examined these setae and the 'gin-traps' were absent.

BIOLOGY

In most species of dermestids the adult beetles need food and access to a water supply for satisfactory reproduction. This was also found by Dick (1937), who states that if beetles were allowed to drink they would continue to lay eggs for 72 days. This is not the case with the smaller carpet-beetles such as *Anthrenus verbasci*, which are able to complete their adult life and lay eggs without any feeding.

The eggs of *Dermestes maculatus* found in decaying carcasses were dirty white and minutely and longitudinally striate and also reticulate when viewed at a certain angle. Most eggs examined varied from 1,30 by 0,54 to 2,04 by 0,92 mm and were fairly dull.

In larvae reared in the laboratory on their natural food supply, the larval life-span varied from 31-42 days during January to March, the pupal stage being 7-11 days. During April to May they needed about 50 days to mature and the pupal stage was about 35 days. Pupation occurs in the larval skin in the soil without the formation of an earthen cell.

The newly emerged beetle is pale yellowish white with the abdominal apex reddish; pronotum pale reddish surrounded by a yellowish-white, broad border. Legs pale, trochanters, tarsi and articulation points of femur, and tibiae reddish; head also pale reddish, eyes brown, antenna reddish with the apical three segments piceous brown, and apices of mandibles black. After a few hours they assume their normal dark coloration.

As indicated previously, during the act of pupation the larvae will perforate any suitable material for this purpose and may cause severe damage to timber in buildings. In the past various instances have been recorded where larvae of this species caused damage amounting to thousands of rands where laminated boards and wooden panels contained animal glue. It is also possible that the larvae may consume some of the wood as part of their diet. This fact is also stressed by Bedwell (1931) when he refers to the smooth hollowed-out parts of the timber and the presence of the larvae in various stages of development.

During the surveys it was observed that the larvae of *D. maculatus* very often

feed on their own pupae and they in turn are heavily preyed upon by larvae of the ham-beetles, particularly *Necrobia rufipes*, which sometimes occur together with this species.

Dermestes ater de Geer

DESCRIPTION

Adult

Previously described by Hinton (1945). Dark castaneous to piceous, integument somewhat more shiny than in *Dermestes maculatus*; body hairs fulvous. Lateral impressed line on first sternum widely curved inwards, only parallel to lateral margin for about half its length (in *D. maculatus* it is parallel for most of its length). Elytral apices without serrations and without sutural teeth. Length varying from 8,3 to 9,5 mm.

Indigenous to America (Fauvel 1889) and widely spread in the world (Hinton 1945). Only occasionally observed in the Cape Town docks.

Larva

Very similar to that of *D. maculatus* (see Fig. 2) in size, body form and setation including spiracles, except for pro-mesothoracic spiracle (Fig. 4B), which in *D. ater* bears about twelve almost equally developed ventral setae, whereas in all specimens of *D. maculatus* that were examined, there were only one strong and about five weaker setae. In this species, as in *D. maculatus*, the first three abdominal spiracles are situated on a non-sclerotized membrane below sclerotized tergal plates, but the abdominal segments are devoid of a transverse row of strong tubercles (Fig. 5C–D). Urogomphi straight (Fig. 5D—in *D. maculatus* slightly curved upwards and anteriorly), and tibiae (Fig. 3M) each with stout dorsal spine on posterior face near apex (in *D. maculatus* it is replaced by long slender seta); short spine-like ventral seta present on each side of base of tarsungulus (in *D. maculatus* these setae are long). In most specimens examined the median, longitudinal yellowish band over the dorsum in the form of a thin line, forming a diamond-shaped patch in middle of each segment.

Head (Fig. 4A)

Very similar to that of *D. maculatus* in shape, sclerotization and setation, but lacking tubercles on frontal area. Six ocelli on each side arranged in more or less two groups of three each, as illustrated. Frontal and coronal sutures distinct. Head of most specimens examined with somewhat more setae than in *D. maculatus* (see Fig. 2E–G), particularly on frontal area. Antennae also very similar to those of latter species, including six dorsal setae on first segment; the sensory appendix, however, seems to be somewhat smaller.

Labrum and clypeus

Very similar to those of *D. maculatus*, including emargination in middle of anterior margin of labrum. *Epipharynx* (Fig. 4E) also similar and with double

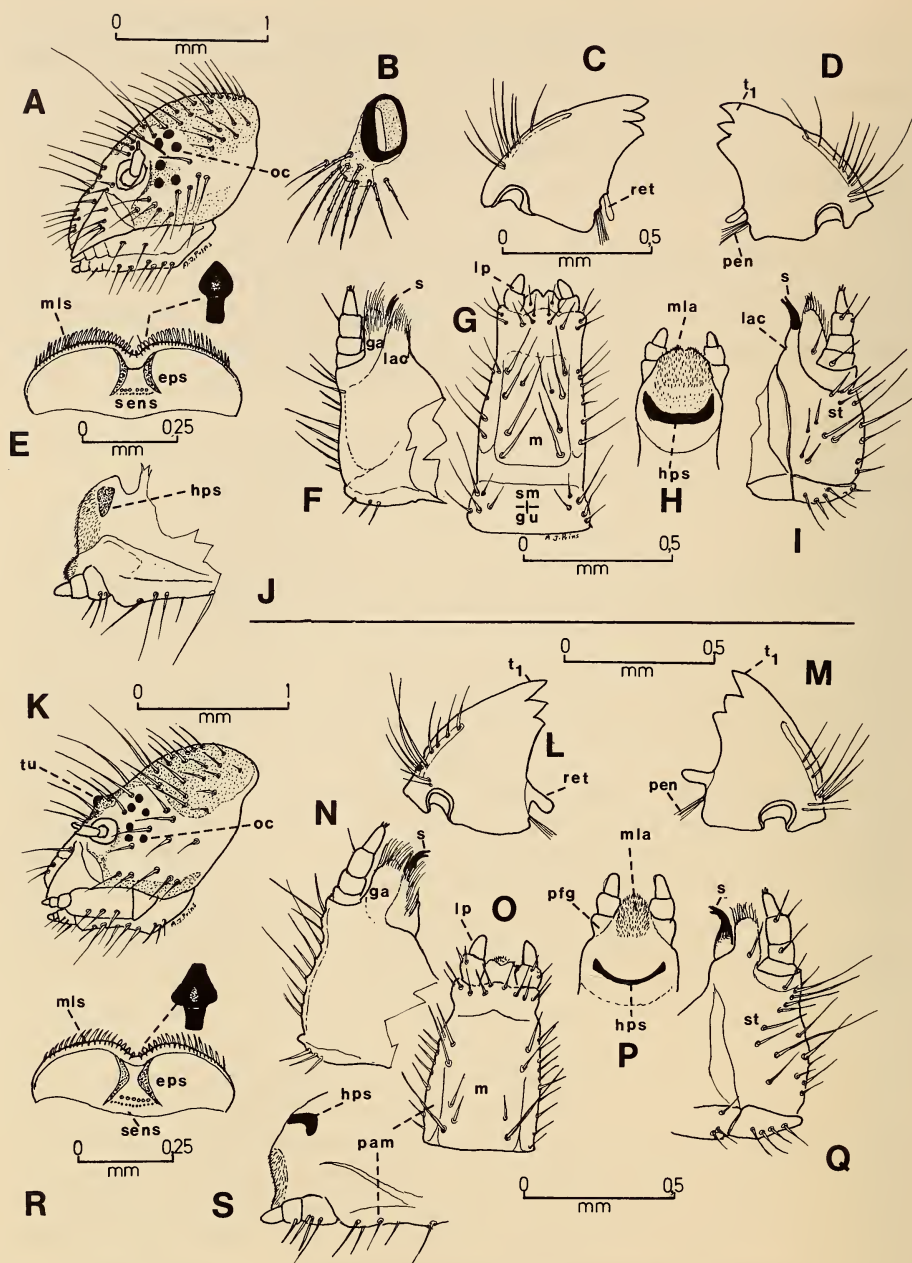


Fig. 4. Dermestidae. A-J. *Dermestes ater* larva. A. Head, left lateral view. B. Promesothoracic spiracle, left lateral view. C. Left mandible, dorsal view. D. Right mandible, dorsal view. E. Epipharynx. F. Left maxilla, dorsal view. G. Labium, ventral view. H. Labium, dorsal view. I. Left maxilla, ventral view. J. Labium, left lateral view. K-S. *Dermestes peruvianus* larva. K. Head, left lateral view. L. Left mandible, dorsal view. M. Right mandible, dorsal view. N. Left maxilla, dorsal view. O. Labium, ventral view. P. Labium, dorsal view. Q. Left maxilla, ventral view. R. Epipharynx. S. Labium, left lateral view.

row of proximal sensory papillae, the front six large, arranged in two groups of three each in most specimens seen; posterior row with about fourteen minute papillae. Epipharyngeal scleromes also similar to those of *D. maculatus* (see Fig. 2H); broad median lobe setae about five in number on each side; lateral lobe setae spear-shaped and covering each lateral margin to a point just beyond its middle.

Mandibles (Fig. 4C–D)

Very similar to those of *D. maculatus*, including demi-srobe and transverse row of hairs; however, retinaculum much narrower and penicilli much broader in most specimens examined than in that species.

Maxillae (Fig. 4F, I)

Similar to those of *D. maculatus* (see Fig. 2K) and without any setae on dorsal side, except for hair brushes on galea and lacinia. Setal pattern of ventral side similar to that of latter species. Demarcation line between galea and lacinia fairly distinct, the spur as in *D. maculatus*. Maxillary palp with third and fourth segments of about equal length and both slightly longer than first and second; apical segment narrowest; setal pattern, subcardo and precardo exactly as in *D. maculatus*, except no setae could be traced on subcardo.

Labium (Fig. 4G–H, J)

Very similar to that of *D. maculatus*, including shape, setal pattern, labial palpi and hypopharynx.

Pupa

Also very similar to that of *D. maculatus* in colour, body form, size and shape of developing genital capsule, but differing from it by the somewhat smaller hair tubercles, which are more or less confined to median area of tergites, particularly the pronotum (Fig. 3C), even in older pupae. In *D. ater* the urogomphi (Fig. 3I) are also more curved anteriorly and are not straight. In most specimens examined there seem to be slightly more setae on the body, and the setae are somewhat finer and more slender.

Dermestes peruvianus Castelnau

DESCRIPTION

Adult

Previously described by Hinton (1945). Dark castaneous brown, clothed with short decumbent fulvous hairs. Integument somewhat more shiny than in *Dermestes maculatus*. Lateral impressed line on first sternite straight and parallel to lateral margin. Elytral apices entire, not serrate and also lacking sutural teeth. Length 6,6–11,0 mm.

Probably a native of South America and widely distributed through the major countries of the world (Hinton 1945). During surveys it was not found on the islands along the Cape coasts; however, it is almost as common as *D. maculatus* in carcasses and fish-meal accumulations around Cape Town.

Larva

Very similar to that of *D. maculatus* (see Fig. 2) in size, body form and setation, including the form of the spiracles; *D. peruvianus*, however, has promesothoracic spiracle with more setae (about twelve) of equal size as in *D. ater*, and only first two abdominal spiracles are situated on a non-sclerotized membrane below sclerotized plates of the two segments (Fig. 5E); also transverse row of strong tubercles present on anterior border of sclerotized tergal plates on

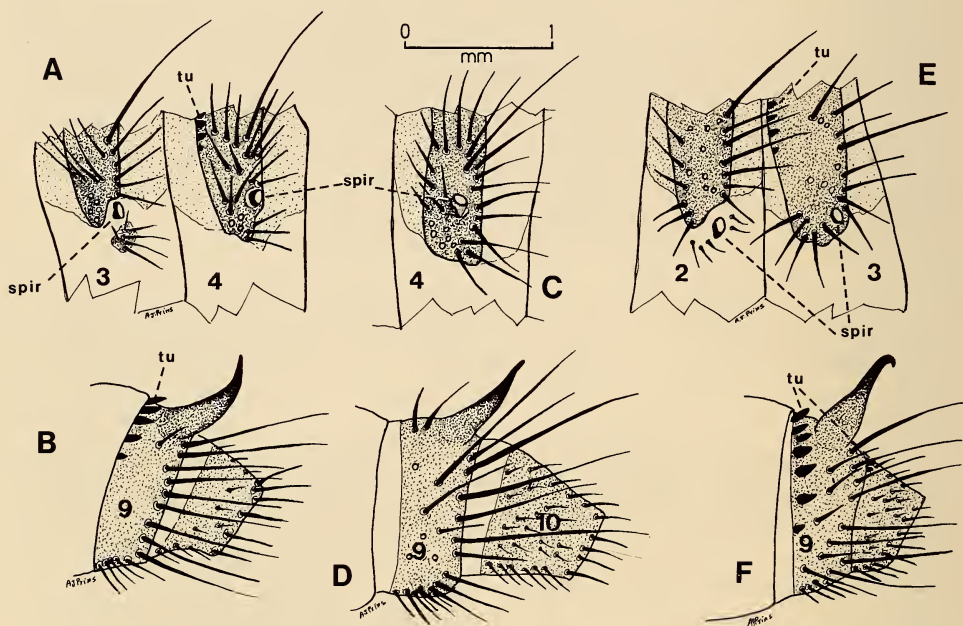


Fig. 5. Dermestidae. A. *Dermestes maculatus* larva, left lateral view of spiracles and tergal plates on segments 3 and 4. B. *Dermestes maculatus* larva, left lateral view of segments 9 and 10. C. *Dermestes ater* larva, left lateral view of spiracle and tergal plate on segment 4. D. *Dermestes ater* larva, left lateral view of segments 9 and 10. E. *Dermestes peruvianus* larva, left lateral view of spiracles and tergal plates of segments 2 and 3. F. *Dermestes peruvianus* larva, left lateral view of segments 9 and 10.

abdominal segments 3 to 10 (Fig. 5E–F). Urogomphi in this species (Fig. 5F) fairly straight, their apices curved caudally and downwards and, when seen from above, slightly divergent as in *D. ater*. Tarsungulus (Fig. 3N) with broad base, on each side with long slender ventral seta, tibiae with long slender posterodorsal preapical seta as in *D. maculatus*.

Head (Fig. 4K)

Very similar to that of *D. maculatus* (see Fig. 2E–F) in form, sclerotization and setation, including two tubercles on frontal area and distinct frontal and coronal sutures. Six ocelli on each side appearing somewhat smaller and arranged in two groups of three each. Antennae also similar to those of latter species, including sensory appendix, but in most specimens examined oval sensory spot placed on posteroventral side of second segment (in *D. maculatus* it is more ventral in position).

Labrum and clypeus

Very similar to those of *D. maculatus* including setation and labral emargination. *Epipharynx* (Fig. 4R) as in *D. maculatus* (see Fig. 2H) with proximal sensory area consisting of an anterior row of six large and a posterior row of about twelve minute papillae. Median setae about three to four in number in most specimens seen and rather broad, their apices either truncate or rounded, the setae somewhat broader than in *D. ater* and rather similar to those of *D. maculatus*.

Mandibles (Fig. 4L–M)

Very similar to those of *D. maculatus*, including broad retinaculum, rather narrow penicillus and transverse row of hairs near mandibular base; each demisrobe also with about four shorter setae. Apical tooth (t_1) the largest.

Maxillae (Fig. 4N, Q)

Similar to those of both *D. maculatus* and *D. ater* in form and setation, including maxillary palpi, forked spur on lacinia and hair brushes on both lacinia and galea. In this species there are also about three setae on subcardo.

Labium (Fig. 4O–P, S)

Very similar to that of *D. maculatus* including setal pattern and hypopharynx. Labial palpi also similar, but differ from those of both *D. maculatus* and *D. ater* by the first segment which bears at least two ventral setae.

Pupa

Similar to *D. maculatus* but the hair-bearing tubercles, particularly on the pronotum (Fig. 3D), although of about the same size, are more or less confined to the median area in *D. peruvianus*, and in the few specimens examined the hind margin of the mesonotum is more rounded in middle (in *D. maculatus* it is more pointed or rather acute). Urogomphi (Fig. 3H) more curved anteriorly as in *D. ater* and not straight as in *D. maculatus*.

SERIES ELATERIFORMIA

Family **Cantharidae**

Small to medium-sized, elongate, somewhat flattened leather-winged beetles, usually with reddish and bluish coloration. Head generally narrower than

pronotum and elytra, deflexed and with filiform antennae. Elytra covering the abdominal segments; tarsal formula 5-5-5. Luminous organs absent. According to Arnett (1963) they are in some ways the most primitive of beetles.

About fifty species have been recorded from southern Africa; their habits are largely unknown. Only one species of the genus *Afronycha* has been observed in animal dung during the surveys.

Afronycha picta (Wiedemann)

DESCRIPTION

Adult (Fig. 6A)

Dark olive green with orange-red head and pronotum marked with dark green. Dull, covered all over with fine, short greyish hairs. Legs orange red. Antennae usually dark; first two segments pale orange red. Length 9,1-11,6 mm.

Wittmer (1960) gives the distribution as Cape Town, Rondebosch, Camps Bay and Paarl. Delkeskamp (1977) mentions only Natal. According to collection data, however, it is widely distributed in the Cape Province.

Larva (Fig. 6B)

A general description of a cantharid larva is given by Peterson (1967). Full-grown larva of *Afronycha picta* measures 17-18 mm long and is velvety brown with somewhat bluish tinge on thoracic segments; each body segment with pale yellowish-brown marks and stripes and thin pale line on lateral margin. Tenth abdominal segment with small fleshy protuberance (Fig. 6L) acting as a proleg. Thoracic legs (Fig. 6J) well developed; claws (Fig. 6I) simple, long and acute, with two small spines near base on posterior side and one on anterior side. Each body segment with gland opening on each side. Spiracles (Fig. 6K) similar to that illustrated by Böving & Craighead (1931), opening almost circular with black, triangular area anteriorly, which, according to above authors, possibly represents the reduced air-tubes. Spiracular opening furnished with fine hairs. Cantharid larvae are campodeiform and orthosomatic.

Head (Fig. 6E)

Brownish with one well-developed ocellus on each side behind antenna. Subnasal sclerite sinuate on each side, with small tooth in middle. Epicranial halves fused ventrally. Antennae three-segmented; second segment about twice as long as first; third very small; second segment with a sensory appendix (Fig. 6F). Mandibles (Fig. 6G) almost falcate, nearly twice as long as wide, with two acute apical teeth; each mandible with a dorsal longitudinal row of fine hairs extending from preartis; lateral margin fairly strongly carinate; ventral side of teeth with conduit for juice. Mala (Fig. 6F, H) small and with long terminal hair. Mentum and stipes (Fig. 6F) clearly marked and fairly well sclerotized; prementum almost triangular. Maxillary palpi appearing four-segmented, but according to Peterson (1967) only three segments are present; apical segment about half as

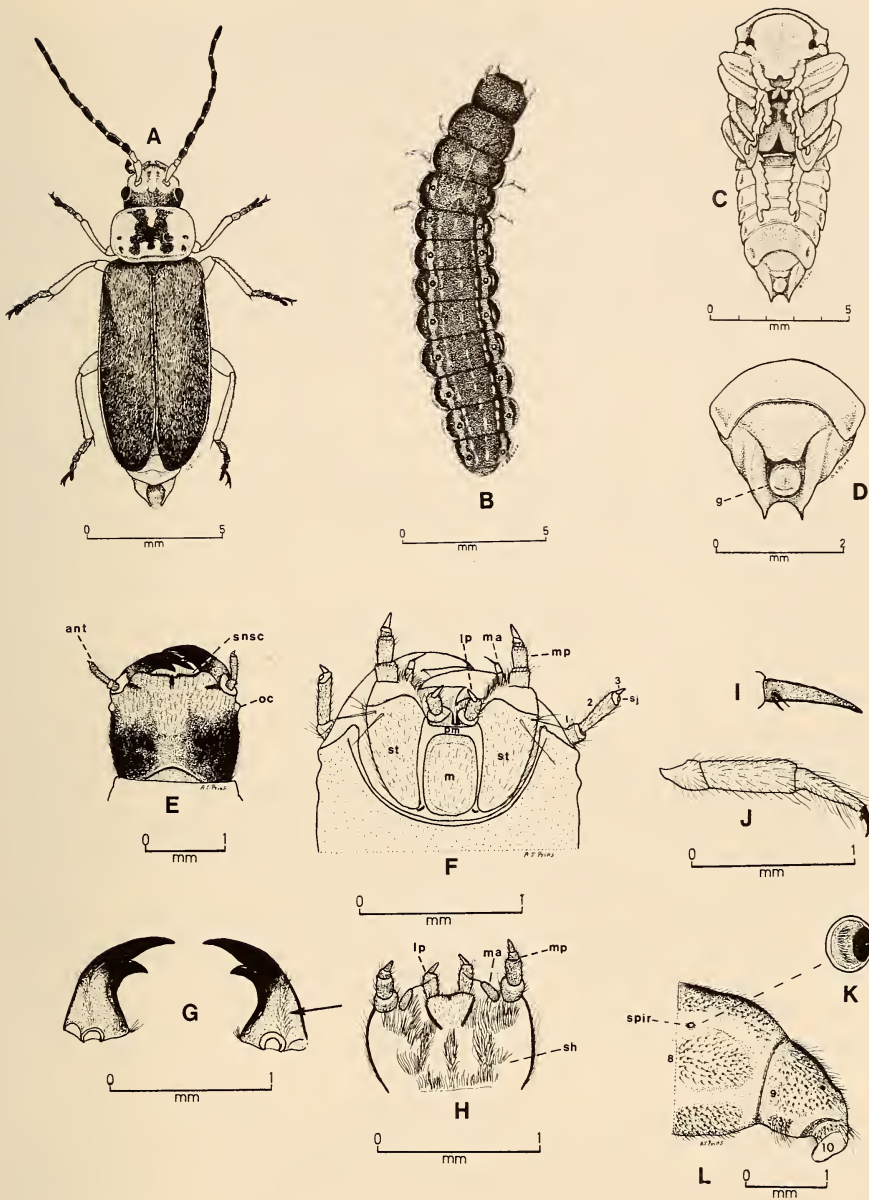


Fig. 6. Cantharidae. *Afronycha picta*. A. Adult. B. Larva, dorsal view. C. Pupa, ventral view. D. Detail of last segment of pupa, ventral view. E-L. Larva. E. Head, dorsal view. F. Head, ventral view showing mentum and stipes. G. Mandibles, dorsal view. H. Hypopharyngeal area, dorsal view to show straining hairs. I. Claw, enlarged to show spines. J. Right mesothoracic leg. K. Right abdominal spiracle to show triangular area and hairs. L. Apical abdominal segments, left lateral view.

wide as preapical one and tapering towards apex; the latter segment the shortest and ring-like. *Hypopharynx* (Fig. 6H) with at least three longitudinal rows of straining hairs.

Pupa (Fig. 6C)

Whitish yellow with reddish eye-spots and extreme apices of mandibles reddish. Specimens examined measure 10,1 mm long and 4,6 mm broad across widest part. Extreme apex of abdomen with two short spines or dents. Developing genital capsule (Fig. 6D) visible as large convex or rounded tubercle. As imago develops pupa becomes darker and apices of mandibles turn almost black; abdomen remains yellowish white and wing covers have piceous tinge.

BIOLOGY

Many species of cantharids are predacious, some feeding on aphids, others on the eggs of grasshoppers and on the larvae of Lepidoptera and Coleoptera; others again are phytophagous; some are omnivorous. The adult beetles often visit flowers where they feed on pollen. The larvae are free-living and predacious, preying on the larvae of other insects.

Young larvae of *Afronycha picta* were collected along the west coast of the Cape Province in fairly fresh as well as semi-fresh cow-pats during midwinter. These larvae are greenish in colour, dotted with tiny black and larger dark-grey spots. As they become older, the colour turns darker, until they assume their normal brownish-velvet appearance. Mature larvae were found in pats during August. They are fairly sluggish and feed on the coprophagous insects, including larvae of dung-flies (*Orthellia* spp.) and flesh-flies (*Sarcophaga* spp.). They have the habit of rolling around with the struggling prey until movement of the latter subsides, by which time half of the prey may have been devoured. The larvae were seen feeding on the juices oozing from wet dung.

The development of the larvae seems to be fairly slow and pupae were only recovered at the end of August and beginning of September from larvae collected in July. The pupal stages lasted about 11 days in the laboratory (19–22 °C); the beetles then emerged during September. In the Darling district they were also observed to emerge from cow-pats during May.

Family **Melyridae**

Small to medium-sized beetles, often with brilliant blue or red coloration, the head nearly as broad as pronotum and with serrate antennae. Elytra entire and tarsal formula 5–5–5 (rarely 4–5–5).

The Melyridae were previously regarded as a subfamily of the Dasytidae but have now been elevated to include the Malachiidae as well as the Dasytidae, the latter containing the most primitive living members of this group. Some authorities, such as Crowson (1952, 1964), regard the true position of this family to be in the superfamily Cleroidea and consider its resemblance to the family Cantharidae merely as a consequence of convergence. Melyrids most closely resemble can-

tharids both in structure and habits; however, the structure of the aedeagus of its members bears a clear resemblance to that of the superfamily Cucujoidea. Melyrid larvae on the other hand seem to be more closely related to the superfamily Cleroidea if certain characters such as the presence of a gular area, urogomphi and abdominal glands (also present in cantharids) are considered. However, the larvae are more free living and are either scavengers or feed on other insects, their larvae and eggs.

The adults are most probably carnivorous, although they are often found on flowers, where some feed on pollen. A few species are phytophagous such as the spotted maize-beetle, *Astylus atromaculatus* (Blanchard), a native of South America which is widespread in the Republic of South Africa. The adults of *A. atromaculatus* attack the flowers of maize, sorghum, etc., and are gregarious, accumulating in large numbers on the plants; it is also poisonous to cattle and sheep (Bedford *et al.* 1974).

A small metallic-blue and orange-coloured species, *Colpometopus basicornis* (Fairmaire), is common in stranded kelp and was also found to feed on the tissues of decaying animal carcasses on the beach, together with individuals of the larger *Melyris viridis*.

Melyris viridis Fabricius

DESCRIPTION

Adult (Fig. 7A)

Dull metallic green or sometimes with elytra coppery green. Each elytron with three distinct striae; whole insect dorsally covered with piliferous punctures. Hairs black and short. Pronotal disc on each side with longitudinal carina extending over anterior two-thirds and ending in raised frontal margin. Pronotum also with shallow, median, longitudinal impression, which is not very obvious in small specimens. Legs setose, lateral side of body fringed with short, fine, black hairs. Pronotum narrower than elytra. Length 9.6–13 mm.

Widely spread along the western and north-western coasts of the Cape Province.

Larva (Fig. 7B)

General description of a melyrid larva is given by Peterson (1967).

Melyris viridis larva subcylindrical, with nine visible abdominal terga; head small. About 19 mm long when fully grown and light brownish red in colour; vistiture consists of long, golden hairs. Prothoracic segment with broad, brown to blackish sclerotized shield, divided by thin, pale reddish, longitudinal (ecdysial) line. Meso- and metathoracic segments each with lateral brownish sclerotized area. Head, legs, and ninth abdominal tergum blackish; latter sclerotized dorsally and bearing two urogomphi which are curved upwards. Urogomphus with small tooth laterally, some distance from apex (Fig. 7G). Legs well developed, increasing in size from front to back; coxa, femur, and tibia well demarcated and furnished with long hairs; tarsungulus (Fig. 7F) moderately long, acute, and with

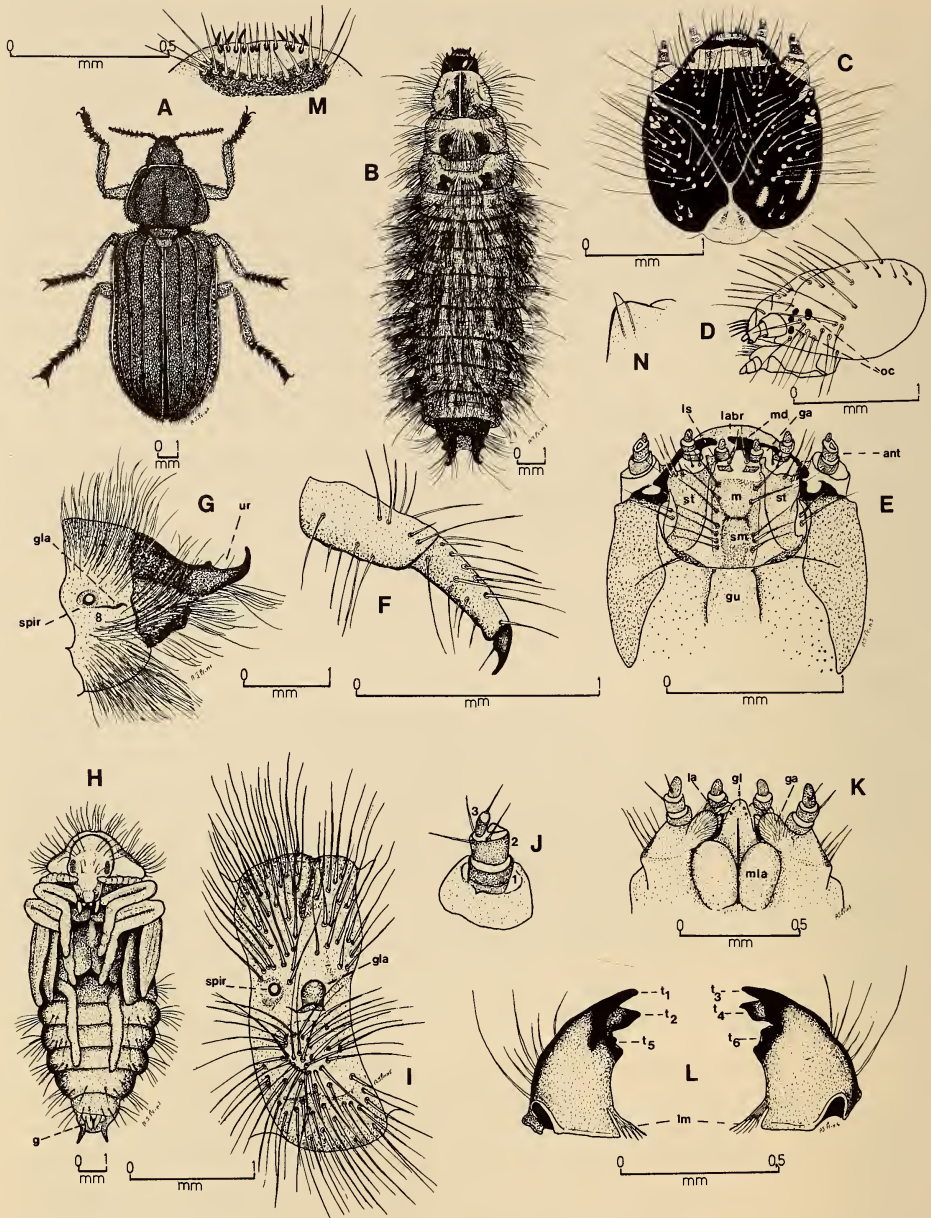


Fig. 7. Melyridae. *Melyris viridis*. A. Adult. B-G. Larva. B. Dorsal view. C. Head, dorsal view. D. Head, left lateral view to show ocelli. E. Mouth-parts, ventral view. F. Right mesothoracic leg. G. Eighth and ninth abdominal segments, left lateral view. H. Pupa, ventral view. I-N. Larva. I. First abdominal segment to show the extruded defensive gland. J. Antenna. K. Maxillae and labium, dorsal view. L. Mandibles, dorsal view. M. Anterior part of labrum, dorsal view. N. Apex of lacinia showing tooth (highly magnified).

single long ventral seta on enlarged base. Two pairs of protrusible, lateral, defensive glands present (Fig. 7I); one pair on first and other pair on eighth abdominal segment; each gland normally indicated by narrow sclerotized slit just behind the spiracle (Fig. 7G). When larva is irritated, glands are evaginated. Crowson (1964) describes the same number of glands in *Astylus atromaculatus* and in *Melyris rufiventris* Boheman. Spiracles annular (Fig. 7I), small, and in most of the mature specimens examined opening is only 0,08 mm in diameter; the mesothoracic spiracle somewhat larger, measuring about 0,10 mm. Anus present as transverse slit, surrounded by single upper and double lower lip (divided by transverse furrow into two parts).

Head (Fig. 7C–E)

Slightly wider than long, black; epicranial suture Y-shaped and epicranial stem (coronal suture) well developed. Both frons and epicranium beset with long golden hairs. Four ocelli on each side, with posterior one largest. Antennae (Fig. 7J) three-segmented, first two segments somewhat compressed laterally and retractable into antennal base; third segment small, with single medium-long seta and some sensory pegs at apex. Second antennal segment with triangular raised area ventrally near apex; also with three medium-long apical setae of which two are lateral and one dorsal in position. Gula clearly demarcated and about as wide as or slightly wider than labium.

Small larvae, only 6,0 mm long, showed same characteristics as mature ones, except for smaller number of setae on labrum.

Labrum and clypeus

Both well developed; labrum about as long as clypeus, and almost semi-circular in specimens seen. It bears median transverse row of long setae as well as second transverse row of shorter setae near extreme anterior margin, each seta placed on a small black sclerotized area (Fig. 7M). Ventral side of labrum with six strong palus-like setae close to anterior margin (clearly seen in Fig. 7M). In most specimens seen, epipharynx bears six large papillae, medially arranged in two rows; four in anterior and two in posterior one; also two small papillae posterior to latter row. Clypeus with only single long seta on each side.

Mandibles (Fig. 7L)

Slightly longer than wide; fairly broad and robust in dorsal view. Dorsal carinae almost absent, mandibles rounded dorsoventrally in this area; however, very weak oblique scrobis present with eight or ten setae, of which proximal one is longest. Stridulatory areas absent; prosthema well developed and situated near the base. True molar area absent, cutting edge broad and almost quadridentate in most specimens. Fairly acute apical (t_1 and t_3) and preapical teeth (t_2 and t_4) are present, latter situated ventrally; proximal teeth (t_5 and t_6) smaller, dorsally situated, usually slightly bidentate and apparently functioning as molar area. Portion of cutting edge between ventral and dorsal teeth shallowly excavated.

Maxillae (Fig. 7E)

Short, galea and lacinia united and almost inseparable. According to Böving & Craighead (1931) lacinia has no spurs in Melyridae. However, apex of lacinia is angular with minute tooth connected to internal tube (Fig. 7N), visible only under high magnification. Galea globular, with large number of fine setae on dorsal side, but ventrally devoid of hairs; two long ventral setae, however, present just posterior to palpal bases. No unci observed. Maxillary palp three-segmented; second segment with lateral and third segment with dorsal seta as well as some sensory pegs. Cardo transverse and with single long seta. Stipes long and clearly demarcated ventrally, with about six long setae apically and two basal setae; dorsally devoid of setae.

Labium (Fig. 7E, K)

Submentum and mentum (apparently the first and second prementum of Anderson (1936)) fairly distinct; the former with three to five long setae on each side, the latter with two to three setae. Prementum of labium visible as two sclerites, each with a single seta; labial palpi two-segmented; gula convex. Glossa (or ligula) pointed, with four sensory spots. Basally two swollen lobes may represent superlinguae of hypopharynx.

Pupa (Fig. 7H)

Dark reddish with whitish antennae, legs, and elytra. Whole body abundantly covered with long golden-brown hairs, particularly on dorsal side. Body has bluish violaceous shine and after few days two brownish eyes become visible. The developing genital capsule present as two short conical projections; extreme apex also with two short, fleshy protuberances. Length 10,5–12,9 mm.

BIOLOGY

Adult beetles of *Melyris viridis* were collected on the beaches and foredune system along the west coast of the Cape Province from Kommetjie to Elands Bay, almost throughout the year. They feed on the pollen of flowers of *Arctotheca populifolia* and *Tetragonia decumbens* and were seen to copulate in large numbers during midwinter (June) and also during the early summer (November) when peak emergence occurred during the surveys. They are attracted to decaying carcasses and cow-dung and were often observed to nibble holes in the leaves and flowers of the above-mentioned plants.

Fully developed eggs dissected from adults in August were brownish red, oval, and varied in size from 0,8 by 0,44 mm to 1,42 by 0,64 mm; they were almost shiny and very superficially reticulate. The eggs are apparently laid during the winter, the mature larvae burrowing into the sand from September to November; eggs that were laid during the summer gave rise to full-grown larvae during the winter. Some of the larvae kept under observation passed the summer in sheltered spots in the sand or under dry kelp, and even under dry cow-pats, and pupated the following April, the beetles then emerging in June. These larvae are

therefore present on the beach for the greater part of the year, except possibly for a short period during the winter and again during the summer. Observations made during 1976 indicated that there were two generations per year with overlapping of adults and larvae. Pupation took place 50–100 mm deep in the sand under plants growing on the upper boundary of the beaches. During mid-summer full-grown larvae and beetles can often be found about 15 cm deep in the sand below plants growing on the beach.

The larvae are omnivorous and feed on semi-dry parts of decaying kelp, partly dry cow-dung, decaying red-bait (*Pyura stolonifera* (Heller)), bird and other animal carcasses, as well as on leaves and flowers of such plants as *Arctotheca populifolia* and certain vygies, and even on vegetables, such as pumpkins, thrown on the beaches. When resting in the sand they were seen to feed on the beach-fleas, *Talorchestia australis* Barnard and *T. capensis* Dana.

SERIES CUCUJIFORMIA

Family **Tenebrionidae**

Small to fairly large, almost round to elongate beetles, varying from white to brown or black, sometimes even with reddish marks. The prognathous head is narrower than pronotum, elytra usually covering the abdomen and often with striae. Tarsal formula 5–5–4.

According to Watt (1974) the primitive forms are relatively large and both larval and adult life is usually long. It is one of the largest families of the Coleoptera, the largest forms occurring in the genus *Psammodes*, measuring up to 60 mm in length. Most of them are adapted to resist desiccation and they are therefore well represented in arid or semi-arid areas and may occur almost anywhere, including birds' nests; however, they are apparently not adapted to living in water.

The adults generally feed on dead vegetable and sometimes also on animal matter. The larvae of most species, however, will feed on living plant tissues—particularly under adverse conditions. When crowding occurs the larvae of most species become cannibalistic. Wings are well developed in the smaller species, particularly the stored-food pests such as the lesser meal-worm, *Alphitobius diaperinus* (Panzer), the common meal-worm, *Tenebrio molitor* Linnaeus, the horned flour-beetles, *Gnathocerus* spp., the confused and rust-red flour-beetles, *Tribolium confusum* du Val and *T. castaneum* (Herbst), the dark flour-beetle *T. destructor* Uyttenboogaart, the long-headed flour-beetle *Latheticus oryzae* (Waterhouse) as well as in the dusty surface-beetles *Gonocephalum* spp. The psammophilous members and toktokkies (*Psammodes* spp.) on the other hand are apterous. Some tenebrionid beetles are able to protect themselves by secretions from defensive glands.

Psammodes species, particularly *P. granulatus* Solier, were common on the sand-dune system together with *Zophosis acuta* Wiedemann. The latter is an endemic southern Cape dune species, which was also occasionally attracted to

decaying kelp on the beach, most probably because of the high water content of the seaweeds, as these insects seem to favour damp substances; *Z. acuta* often appeared under semi-dry cow-dung some distance from the shore.

An unidentified small, black, ant-like tenebrionid, *Herpiscius* sp. (Fig. 8K), with glabrous elytra was very common in debris on the small foredunes skirting the beaches along the west coast. The larvae feed on the roots of the dune plants, and the white pupae (Fig. 8L) were usually found in the loose sand during the summer and early autumn. One often sees these beetles running on beds in houses and rondavels of holiday-makers near the beach, where they are generally mistaken for ants or small spiders. Further away from the coast, they have been found to visit dry cow-pats during the warm months, probably for the shelter provided by the hard crust of the dung.

In Zimbabwe the matt, dark-brown to blackish *Herpiscius sommeri* Solier, which, according to collection data, is widely distributed in the Cape Province, was found to occur in large numbers among the stilt roots of the young maize plants. It is rather similar to the previously mentioned unidentified species of *Herpiscius*, but is easily distinguished by the distinct longitudinal striae on the elytra. *Herpiscius sommeri* beetles were responsible for the destruction of the anchor roots, causing severe damage to the maize plants (Rose 1964). Other tenebrionids common in the debris under the loose sand on the dunes were species of *Phaleriderma* and *Gonopus*, but their habits are unknown.

Dry cow-pats, particularly those that are fairly large, provide shelter for a variety of tenebrionids, especially in open veld. The most common species found during the surveys were the dusty surface-beetles, *Gonocephalum arenarium* (Fabricius) and *G. simplex* (Fabricius), both of which occurred during the late summer and winter months in most of the areas visited, often in association with *Blenosia exarata* (Quensel), a dull-blackish beetle endemic to the Cape.

At least four species of mouldy beetles (subfamily Eurychorinae) were collected under dry pats, of which the widely distributed *Eurychora ciliata* (Fabricius) is the largest, measuring 13–14 mm in length. *Lycanthropa plana* Haag, 6–7 mm in length, is more brownish and is endemic. Specimens of *L. plana* which are indistinguishable from *L. litoralis* Koch were collected near Saldanha, and may indicate that the existence of *L. litoralis* as a species as suggested by Koch (pers. comm.) may not be valid. These beetles were all very plentiful along the west coast. The genus *Geophanus*, another member of this subfamily, was represented by a rather small, unidentified, black species (4–5 mm long). Although rather scarce, it occurred in the same localities as the other members of this group.

Trachynotus reticulatus (de Geer) is blackish, elongate, 13–14 mm long, and is characterized by a strong carina on each elytron. It was observed in association with two other black forms, viz. *T. acuminatus* Quensel and an unidentified molurine species; both of the latter species lack the rugosity of *T. reticulatus*. Several *Psammodes* species were also found in greater abundance, but the common ones were rarely seen under cow-pats. However, one large unidentified toktokkie, about 20 mm long, occurred in the Karoo during the summer and autumn months.

The genus *Hologenosis*, which is rather similar to the previously mentioned genus *Zophosis*, was represented by a dull-black, unidentified species of about 5,8 mm long; it was found to be quite common in the Karoo. A dorsoventrally flattened, dark-brown species of *Blastarnus* (near *pruinosis* Fairmaire), with seven to eight longitudinal carinae on the elytra, occurred together with the species of *Hologenosis*. The related *Emyon* sp. (near *brunnipes* (Erichson)) found with them, resembles a snout-beetle and is dark, castaneous brown, and of about the same length as the *Hologenosis* sp.

The black, long-legged *Stenocara dentata* (Fabricius) (about 13 mm long) occurred in the vicinity of Calitzdorp under dry pats devoid of any other insects. Its body is covered with small tubercles and the shiny longitudinal costae on the elytra are also tuberculate. The related *S. longipes* (Olivier) of about the same size, its body with larger tubercles and lacking true costae, is another very common species in the western Cape Province. It occurs under dry and even semi-fresh cow-pats, often in association with the smaller and shiny, dark-brown *Ograbies subdentatus* Koch and the dull dark-grey *Asida unigena* Peringuey, both of which are endemic to the Cape. From observations it seems that under certain circumstances these beetles feed on the damp particles of the dung. This also seems to be true in the case of the shiny black *Eutochia pulla* (Erichson), which is very similar to *Alphitobius diaperinus* (Fig. 11D), and which is widely distributed in the Subsaharan region. *Eutochia pulla* may, however, be easily distinguished from *A. diaperinus* by its somewhat longer, almost moniliform antennae, better-developed striae on the elytra, and by the posterior margin of the pronotum, which is less sinuate on each side.

At least two greyish species of *Cryptochile*, both marked with brown patches and also characterized by two strong carinae on each elytron, were found under semi-dry to fresh cow-pats in the western parts of the Cape Province. They were accompanied by a small, black species of *Horatoma*, whose presence was probably coincidental, and occasionally by a dull-black meracanthine, *Acanthomera dentipes* (Fabricius).

The masses of stranded kelp on the intertidal and supratidal zones attracted very few tenebrionids apart from the already mentioned *Gonocephalum arenarium* and *Zophosis acuta*, and the pale psammochromic *Pachyphaleria capensis* (Castelnau), which feeds in both the adult and larval form on the stipe and fronds of the large *Ecklonia maxima*, and probably also on *Laminaria pallida* and *Macrocystis angustifolia*. According to Griffiths and Stenton-Dozey (pers. comm.) this last-mentioned beetle forms one of the most important elements of individual kelp strings.

Gonocephalum arenarium (Fabricius)

DESCRIPTION

Adult (Fig. 8A)

Dull, dark-brown to blackish species, covered with yellowish-brown to greyish-brown adpressed hairs giving it a dark-greyish appearance. The two

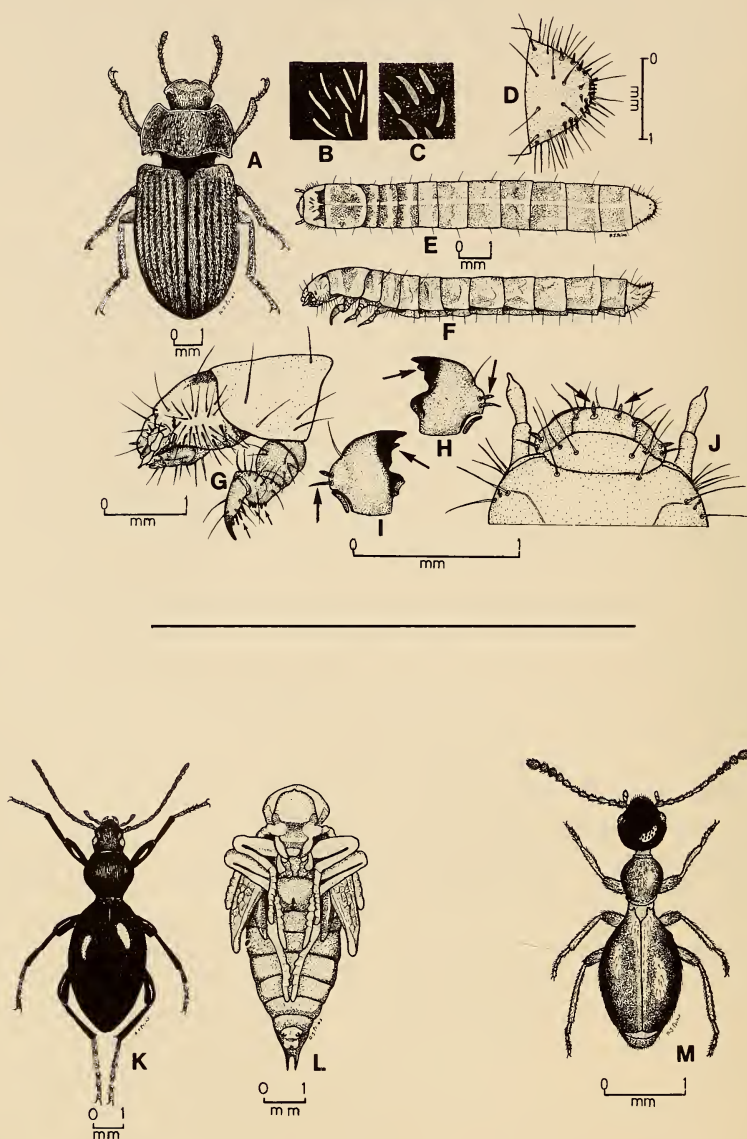


Fig. 8. Tenebrionidae, Anthicidae. A-B. *Gonocephalum arenarium* adult. A. Dorsal view. B. Body setae enlarged. C. *Gonocephalum simplex* adult, body setae enlarged. D-J. *Gonocephalum arenarium* larva. D. Apical abdominal segment, dorsal view. E. Larva, dorsal view. F. Larva, left lateral view. G. Head and first leg, left lateral view. H. Right mandible, dorsal view. I. Left mandible, dorsal view. J. Front part of head, dorsal view. K-L. *Herpiscius* sp. K. Adult. L. Pupa, ventral view. M. *Anthicus apterus*, adult.

species *Gonocephalum arenarium* and *G. simplex* (both found under cow-pats in the western Cape) can be separated by the structure of the body hairs (Fig. 8B–C), those of *G. simplex* being flattened, almost scale-like.

According to collection data in the South African Museum *G. arenarium* is widely distributed in the Cape, South West Africa, east Africa, and is also present on some of the islands along the Cape coast.

Larva (Fig. 8E–F)

Full-grown larvae are about 16 mm long and pale, yellowish red in colour; young specimens usually with pale, yellowish-white, longitudinal line over dorsum of body. Claws simple, acute and rounded on dorsal side, but almost flat ventrally and bordered on each side by a trenchant ridge, which extends nearly from apex to base; spine at this point present on each side, posterior one rounded and broad, other one longer and pointed. Front legs much more strongly developed than others. Mandibles (Fig. 8H–I) broad, only slightly longer than wide, and clearly divided into cutting and molar areas; former longer in left mandible; each cutting edge with preapical ventral tooth. Both molar areas pointed distally when seen from above. Each mandible with lateral carina running from extreme apex almost to middle, with long seta at this point on lateral face; also with dorsal carina which is fairly rounded longitudinally and bearing two spines dorsally; anterior spine short and rounded, posterior one longer and pointed. There are also two short spines placed medially on labrum of *G. arenarium* (Fig. 8J), which Jack (1918) does not record in *G. simplex*.

Jack (1918) describes the larva of *G. simplex* and it appears to be very similar to *G. arenarium*, possessing almost the same number of spines on the ventral side of the front legs (Fig. 8G) and thirteen to twenty-one spines on the anal segment (Fig. 8D). They differ, however, in that *G. arenarium* has one small basal spine or strong seta (or two in some cases) laterally on each pseudopod, which, according to Jack, is absent in *G. simplex*.

BIOLOGY

The dusty surface-beetles are polyphagous and may attack both roots and stems of various wild plants and vegetables. The larvae of *G. arenarium* have been collected during October to December on the foredune system feeding on the roots of the dune plants, the adult beetles emerging during January. The beetles were found to feed on the leaves and stems of *Arctotheca populifolia* along the west coast, causing feeding marks similar to those made by boring caterpillars. Adults of this species were also observed under stranded kelp along the west coast, just above the high-water mark.

Gonocephalum arenarium, together with the dull-black scarab, *Trox horridus* Fabricius, was collected by members of the Percy FitzPatrick Institute of African Ornithology of the University of Cape Town during their surveys on Malgas and Marcus islands near Saldanha as well as on Dassen Island. Although they describe the vegetation on Marcus Island as being rather sparse and

G. arenarium is usually associated with plants, the material brought to the islands by cormorants for nesting purposes may fulfil this beetle's needs.

Pachyphaleria capensis (Castelnau)

DESCRIPTION

Adult (Fig. 9A)

Oval, pale straw-coloured to pale yellow. Some specimens with darker patch in middle of elytra; head somewhat darker, in some specimens piceous. Finely punctured, sparsely on elytra; latter with about seven weakly developed striae each, smooth and fairly shiny. Pronotum on each side just in front of hind margin with small, somewhat oblique impression. Length 6,6–7,5 mm.

Widely distributed along the Cape coasts and collected as far north as South West Africa.

Larva (Fig. 9B–C)

Subcylindrical or somewhat flattened; 13–16 mm long when fully grown, pale straw yellow with darker or brownish patches on dorsum. Latter divided by distinct ecdysial suture, which is fairly clearly visible over first four to six abdominal segments. Pronotum somewhat larger than other segments. Sparsely covered with fine golden-brown hairs. Ninth abdominal segment (Fig. 9D–E) somewhat wider than long, rounded in dorsal view, excavated in middle and bearing six to eight strong, short spines on posterior border, which is slightly emarginate in some specimens. Four long setae present dorsally near anterior margin. Pygopodia small. Abdominal spiracles circular, those on first segment slightly larger than others, usually visible on ventral side. Mesothoracic spiracle oval, larger than those on abdomen. Apart from medium-long and shorter spine-like setae, integument is covered with minute spines, only visible under high magnification (Fig. 9G). Legs (Fig. 9F) well developed, with reduced number of spines; those on prothorax somewhat stronger; tarsungulus of each leg simple and acute and with single ventral and posterolateral spine near base.

Head (Fig. 9H, J–K)

Cranium nearly twice as wide as long, with sides fairly convex and somewhat emarginate. Brownish yellow to straw yellow in colour; frontal and coronal sutures fairly distinct, frontoclypeal suture well demarcated. Very minutely reticulate and fairly shiny, sparsely punctate, the punctures shallow; chaetotaxy as illustrated. Hind margin ventrally deeply emarginate in middle; postgenae separated by poorly demarcated gula. Neck absent. Antennae (Fig. 9I) tubular, second segment somewhat longer than first and wider distally, bearing some minute setae apically; third segment small, much shorter than second and bearing long seta apically as well as two or three smaller ones. Five darkly pigmented, almost black ocelli present laterally, appearing as one eye when seen from above.

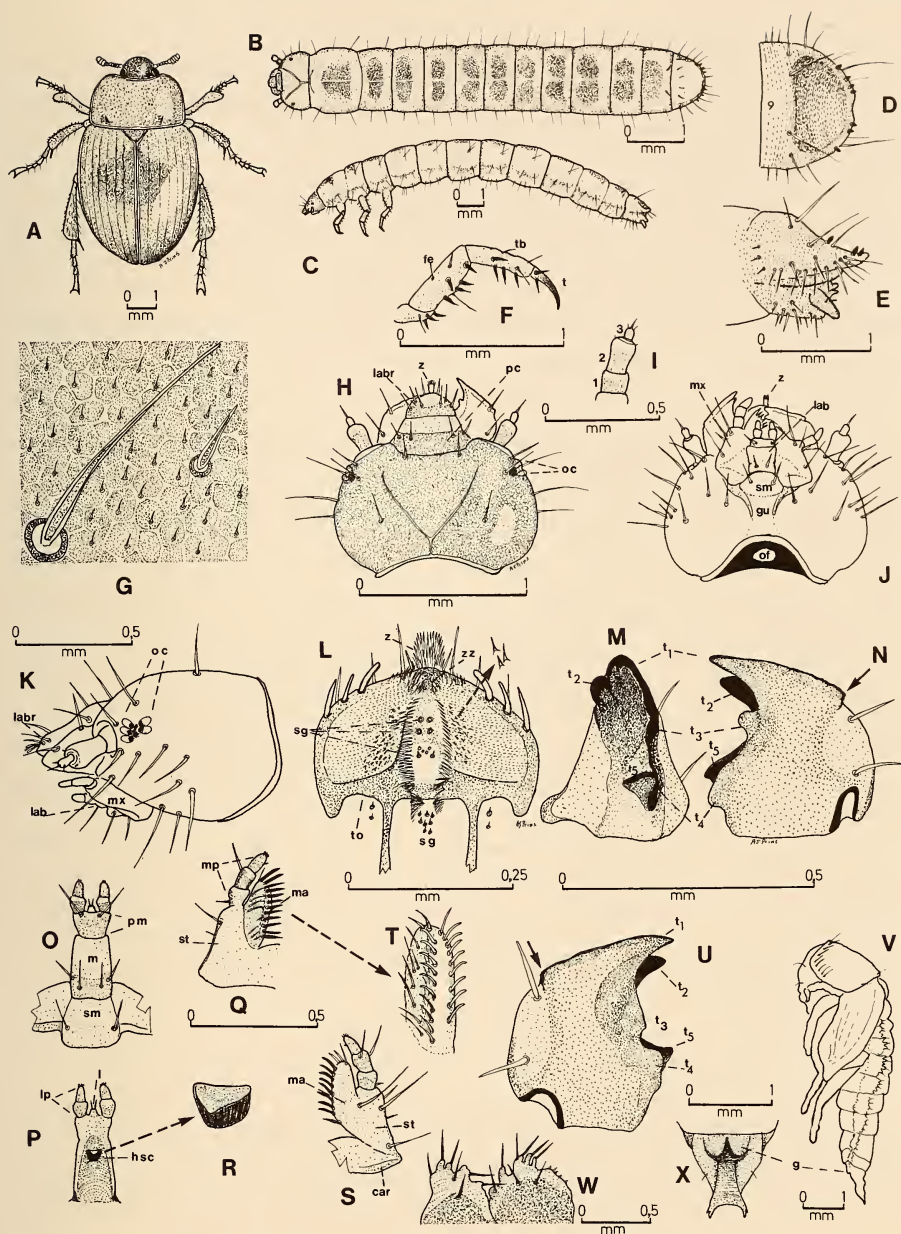


Fig. 9. Tenebrionidae. *Pachyphaleria capensis*. A. Adult. B-U. Larva. B. Dorsal view. C. Left lateral view. D. Ninth abdominal segment, dorsal view. E. Ninth abdominal segment, left lateral view. F. Right mesothoracic leg. G. Integument, highly magnified. H. Head, dorsal view. I. Antenna. J. Head, ventral view. K. Head, left lateral view. L. Epipharynx. M. Right mandible, dorsal view. N. Right mandible, cephalic view. O. Labium, ventral view. P. Hypopharynx. Q. Left maxilla, dorsal view. R. Hypopharyngeal sclerite enlarged. S. Left maxilla, ventral view. T. Mala of left maxilla, cephalic view. U. Left mandible, dorsal view. V-X. Pupa. V. Left lateral view. W. Comb-like structure on first and second abdominal segments. X. Apex, ventral view.

Labrum and clypeus

Labrum free, with anterior margin very rounded or convex and bearing six strong spine-like setae dorsally, as well as three smaller setae on each side on anterior margin. Clypeus almost trapezoidal and with four setae on stronger sclerotized postclypeus.

Epipharynx (Fig. 9L). Tormae symmetrical; posterolateral processes short and triangular median ones long and slender; the anterolateral extensions present seem to be better developed and longer on right side, furnished with fine hairs which form oval patch on each side of raised oblong central disc; the hairs on each side extending on to central posterior area behind which are eight small spines or sensilla; fine setae also extending on to anterior part (zz), forming a fairly large brush (z) on anterior margin, also visible dorsally. Central disc with four large anterior and four smaller posterior sensilla, as well as two short spines posterior to these. Laterad of each posterior tormal process two spines present in most specimens examined. lateral margin anteriorly with three strong sickle-shaped or lanceolate spines of which front one is apically rounded and somewhat more strongly developed.

Mandibles (Fig. 9M–N, U)

Similar to those of *Gonocephalum arenarium* (Fig. 8H–I). Broad, left mandible slightly longer than wide, right one about as wide as long. Cutting edge bidentate, lower tooth (t_2) more rounded in some specimens; upper one (t_1) acute when seen from the dorsal side. Upper tooth (t_1) on each mandible extended dorsolaterally as trenchant ridge almost to molar area; latter with broad almost rounded tooth (t_4) dorsally and also extended ventrally as broad tooth (t_3); whole forming an almost triangular ridge on both mandibles (Fig. 9M). On right mandible an extra rounded tooth (t_3) present dorsally about half-way between apex and molar area; on left one only an indication of this tooth present. Lateral margin has a break at about middle, lateral face sloping down from this break, with weaker sclerotization and bearing two strong dorsal setae.

Maxillae (Fig. 9Q, S–T)

Mala fairly broad, tapering to apex, with some fine, long hairs dorsally in two longitudinal rows next to spines and some near lateral margin. Mesal margin with two rows of spines or spine-like setae, curved at their tips, about twelve in dorsal and nine in ventral row. Stipes ventrally with three long setae and two shorter setae on lateral side, of which distal one is largest. Maxillary palp three-segmented, with first two segments of about equal length, apical one shortest and with about twenty sensory pegs at apex and minute seta in about middle on mesal side; second segment with one ventral and one lateral seta, and some minute spines near apex; first segment also with minute spines near apex and short seta on external lateral margin near base. Cardo without setae.

Labium (Fig. 9O)

Submentum somewhat trapezoidal, with two long setae. Mentum long, almost barrel-shaped or even tubular in some, with four setae. Prementum with two setae. Ligula short, about half the length of first palpal segment and bearing two apical setae and some minute spines on dorsal side. Palp two-segmented, with segments of about equal length; apical one with about twenty sensory pegs at apex; first segment with minute dorsal spines and a tiny lateral seta at base in most specimens examined.

Hypopharynx (Fig. 9P, R) medially raised and convex from side to side and conical, hypopharyngeal sclerite as short, broad, truncate tooth, almost triangular in some specimens.

Pupa (Fig. 9V–X)

Whitish at first, but becoming yellowish later; about 6 mm long. Row of fine golden setae present on front margin of pronotum, extending along anterior part of lateral margin. About four setae present on head. 'Gin-traps' absent from median area of abdominal dorsum, but each segment with lateral comb-like extension (Fig. 9W) bearing four to six setae. Number of setae and fleshy protuberances diminishing posteriorly. First seven pairs of spiracles clearly visible laterally in fold formed by comb-like extensions; first two pairs of spiracles close together and more or less covered by wings; eighth pair inconspicuous. Extreme apex (Fig. 9X) has appearance of flat lobe, widening posteriorly, with two spines on each corner, lateral ones shortest. Developing genital capsule takes shape of two swellings; in some with extra projection of about same length laterad of each conical swelling.

BIOLOGY

Pachyphaleria capensis beetles are found on the beach all the year round and feed on decaying and fresh kelp. In areas where kelp is scarce they become scavengers and feed on animal or bird carcasses on the beach. They were found in wet sand under kelp at a depth of 150 to almost 300 mm. Larvae of this species were collected along the west coast of the Cape Province during the autumn and early winter and feed mostly on the fresh parts of washed-up kelp. When confined to a small space or when food becomes scarce they become cannibalistic. As in the case of the beetles, the larvae will feed on bird carcasses when kelp is not available. There is a short prepupal stage of 2–4 days. Pupae are found in loose or hollowed-out chambers in the damp sand and are usually hooked to the remains of the larval skin. In the laboratory, pupal stages lasted about 16 days during May.

Tribolium destructor Uyttenboogaart

DESCRIPTION

Adult (Fig. 10A)

Dark-brown to piceous-brown, elongate beetle, 3.9–5.3 mm long. Head and pronotum fairly densely punctured; punctures large and oval; elytra each with

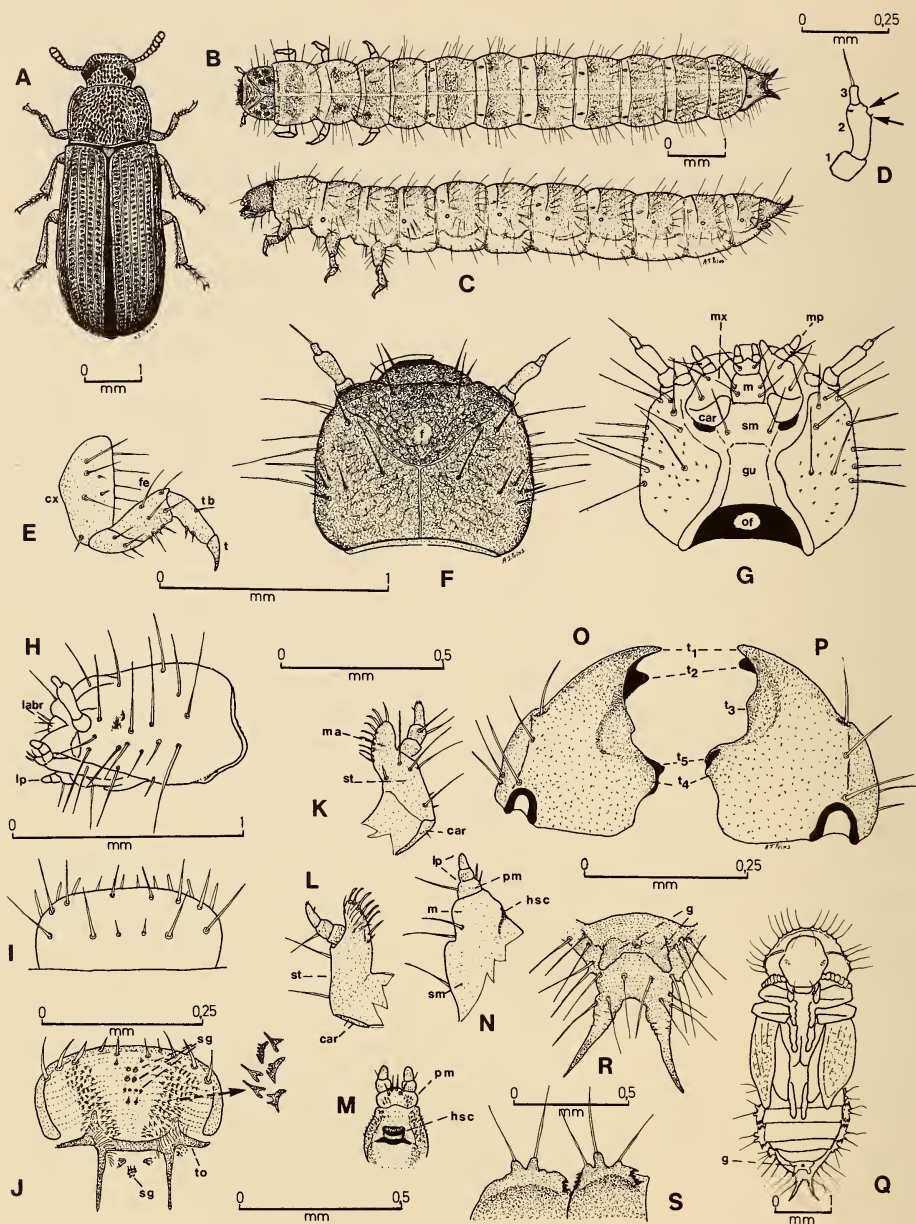


Fig. 10. Tenebrionidae. *Tribolium destructor*. A. Adult. B-P. Larva. B. Dorsal view. C. Left lateral view. D. Antenna. E. Right mesothoracic leg. F. Head, dorsal view. G. Head, ventral view. H. Head, left lateral view. I. Labrum, dorsal view. J. Epipharynx. K. Left maxilla, ventral view. L. Left maxilla, dorsal view. M. Hypopharynx. N. Labium, left lateral view. O. Left mandible, dorsal view. P. Right mandible, dorsal view. Q-S. Pupa. Q. Ventral view. R. Abdominal apex, ventral view. S. Comb-like structure on first two abdominal segments.

nine to ten longitudinal striae and with row of large shallow punctures between striae, lateral ones more conspicuous; area between punctures very finely reticulate and whole insect therefore fairly shiny. Only legs and antennae covered with fine yellowish-brown hairs.

Tribolium destructor belongs to the *confusum*-group (Hinton, 1948), but may easily be distinguished by its larger size and the fact that the narrowest part of the eye, where it is divided by a carina on the side of the head, is usually as broad as two facets of the eye, and the frons is beset with punctures that are as long as the eye facets. In *T. confusum*, the narrowest part of the eye is no broader than one facet.

This species is widely distributed in the Republic of South Africa according to collection data and often appears in stores and butcheries in the western Cape. It is a native of Africa and is also a pest in North America (Hinton 1948).

Larva (Fig. 10B–C)

General body colour creamy white or whitish yellow, most segments brown dorsally; the head, thoracic and last two abdominal segments darker. Ecdysial suture distinct. Length 9.5–10 mm when fully grown. Body subcylindrical to almost cylindrical and sparsely covered with long golden setae, more or less arranged in two rows on each segment. Urogomphi short, acute, divergent and directed upwards. Spiracles circular, visible laterally; mesothoracic pair very slightly larger than others. The pygopodia can be retracted into the ventral aperture of the ninth segment.

Legs (Fig. 10E) well developed, all of about equal length and with a reduced number of setae. Tarsungulus acute, simple, without spines and slightly shorter than length of tibia. Dorsal integument very similar to that of *Pachyphaleria capensis*, with long setae and short spines, but lacking minute spicules.

Head (Fig. 10F–H)

Cranium only slightly wider than long, minutely reticulate, only slightly shiny and also somewhat rugulose, particularly the frons. Frontoclypeal suture well developed; frontal and epicranial sutures inadequately indicated. Antennae (Fig. 10D) three-segmented, second segment about twice as long as first, with small sensory tubercle on anteroventral side as well as at least one or two minute spines below it and one situated dorsolaterally; third segment small, about as long as first, with a medium long apical seta. One or two pigmented eye-spots visible behind antennal base, but separate ocelli not demarcated in specimens examined. Postgenae ventrally separated by fairly wide gula. Neck absent. Setation as illustrated; some setae very long. Head capsule, particularly side and ventral part, with numerous small spines.

Labrum and clypeus

Labrum (Fig. 10I), which is partly concealed by clypeus when viewed from above, is characteristic of this species. Clypeus about three times wider than long,

its anterior margin almost straight or slightly concave in most specimens seen and bearing two medium-long setae on each side. Labrum much shorter than clypeus and slightly more than twice wider than long; setal pattern as illustrated.

Epipharynx (Fig. 10J). Under high magnification four large sensory spots or cones visible on raised median area and just posterior to these a transverse row of four minute sensory cones present, as well as two small spines. Most specimens examined also with two large sensory cones near anterior margin, just posterior to paramedian setae. Setation of each side of median area consists of minute spicules, which are either simple or with two to four teeth. Tormae symmetrical, on each side with oblique row of fine hairs as well as two sensory cones and group of eight tiny sensory spots or spines between posterior arms. Anterior margin with four short setae and three large almost sickle-shaped setae posterior to these on each side.

Mandibles (Fig. 10O–P)

Somewhat longer than wide, with break on lateral margin not so obvious as in *Pachyphaleria capensis*. Each mandible with two setae situated on short, oblique rounded dorsal carina, as well as one long anterior and two posterior setae on lateral face; latter setae situated ventrally near base. The median tooth (t_3) on right mandible much less pronounced than in *P. capensis*.

Maxillae (Fig. 10K–L)

Mala devoid of setae on ventral side, except one spine-like seta near base in some specimens; dorsally, however, with some long hairs and mesal margin with two rows of spines, seven to ten on each side (as in *P. capensis*). Stipes with three long ventral setae, one seta on lateral side near palpifer and about two short setae near cardo; dorsally devoid of setae. Cardo without setae, except for one or two very short ones in some specimens. Maxillary palp three-segmented; segments short; first two nearly of equal length; the second with one lateral and one ventral seta; apical segment somewhat longer and with some sensory cones at apex and minute seta on mesal margin some distance from apex.

Labium and hypopharynx (Fig. 10M–N)

Similar to that of *P. capensis* (including ventral setae), but ligula absent and mentum shorter. Hypopharyngeal sclerite is more oval, appearing cup-shaped and in most specimens examined with roughly M-shaped sclerotized band or base posterior to it. Glossa with four setae between and posterior to two-segmented palps. Surface of glossa and area around hypopharyngeal sclerite covered with minute spines. In lateral view submentum is raised above level of mentum. Labial palp with apical segment somewhat longer than first and with seta on external margin near base.

Pupa (Figs 10Q–S, 12B)

Length about 5 mm; at first pale or whitish except for apical spines, which are brownish or yellowish. It gradually darkens in colour and just before imago

emerges it becomes piceous. The pupa of *Tribolium destructor* is rather similar to that of *P. capensis* (see Fig. 9V–X), but is more elongate, with somewhat more hairs on the body, particularly on abdomen. It differs from the latter by smaller size and longer apical spines. Developing genital capsule (Fig. 10R) takes shape of two fairly long diverging, conical projections, which in the case of *P. capensis* are placed more parallel. Lateral extensions of abdominal segments (Fig. 10S) each with two conical tubercles and two to three setae (at least three to four in *P. capensis*); anterior and posterior teeth strongly developed. Spiracles similar to those of *P. capensis*.

BIOLOGY

Larvae of *Tribolium destructor* were collected during September in butcheries around Paarl and Wellington in sawdust sweepings containing small bits of meat and dust. Their life-span was fairly long, at least 4–6 months, and pupae formed during October to December produced beetles after 12–23 days. During the winter months the pupal stage was somewhat longer. In most cases pupation occurred in the sawdust mixture without the construction of pupal cells.

The newly-emerged beetles have yellowish-white elytra, with pale yellowish-brown head, thorax and legs. After a day or two they become castaneous brown and may remain pale coloured for up to 8 days, after which they attain their normal piceous or brownish-black colour.

Alphitobius diaperinus (Panzer)

DESCRIPTION

Adult (Fig. 11D)

Blackish-brown to almost black, shiny, slightly oval beetle, whole dorsal surface of head and pronotum finely punctured; each elytron with about six weakly developed, longitudinal, punctured striae with some punctures in between striae. Hind margin of pronotum sinuate on each side, antennae short, about as long as length of pronotum, incrassate towards apex. Legs short. Length about 6 mm.

Cosmopolitan (Andres 1931; Cotton 1941) and commonly found in South Africa.

Larva (Fig. 11A)

Subcylindrical and very similar to that of *Pachyphaleria capensis* (see Fig. 9B), creamy white, with brownish coloration on tergal plates, ecdysial suture as thin whitish line along middle of dorsum, only faintly visible on second to last abdominal segments in most specimens seen. Pronotum somewhat larger than other segments as in latter species; whole body sparsely covered with fine golden hairs. Ninth abdominal segment (Fig. 11B) convex, triangular when seen from above; apex ending in an upcurled spine; laterally and dorsally with about sixteen spine-like setae, also with some long slender setae, particularly on ventral side; dorsally also four long setae in transverse row in about middle of segment.

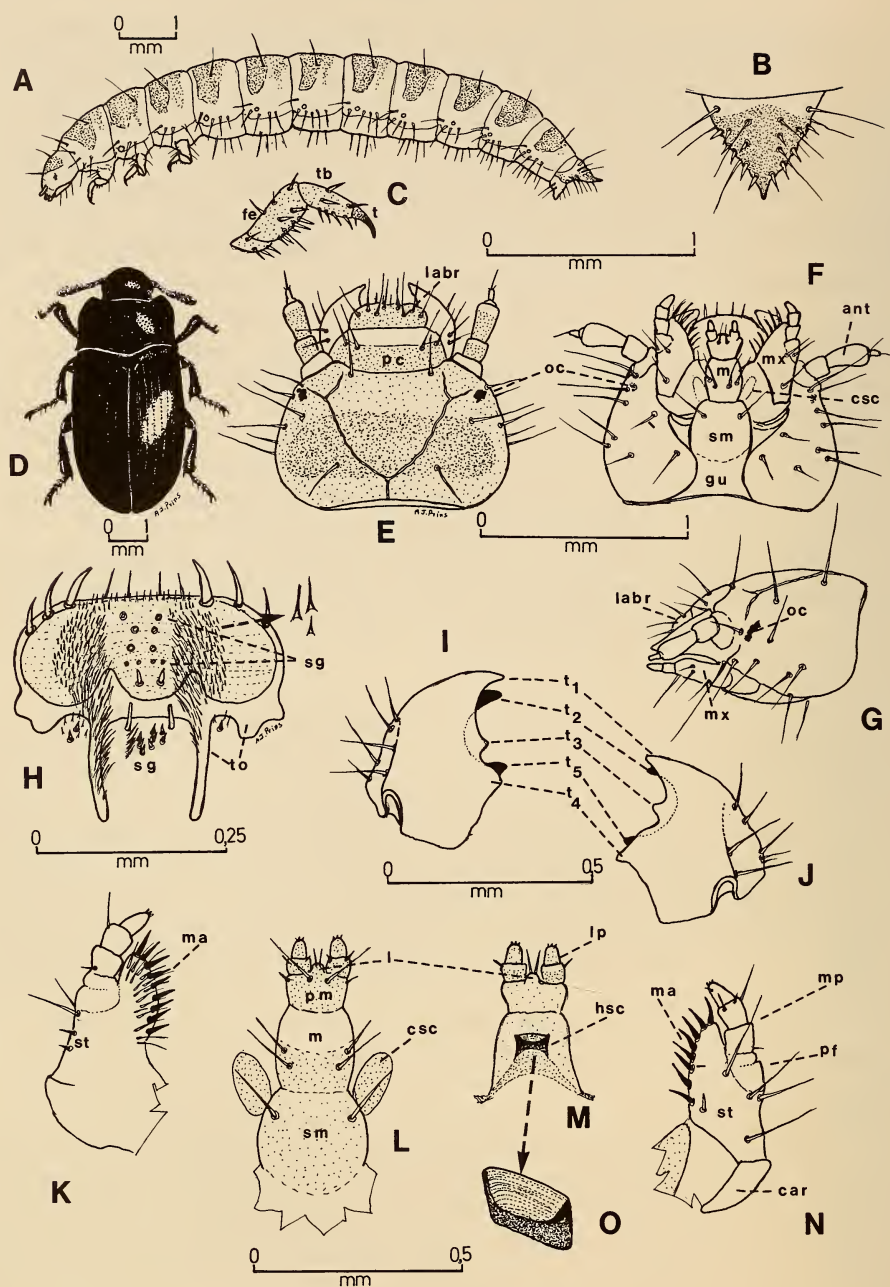


Fig. 11. Tenebrionidae. *Alphonseus diaperinus*. A-C. Larva. A. Left lateral view. B. Ninth abdominal segment, dorsal view. C. Right mesothoracic leg. D. Adult. E-O. Larva. E. Head, dorsal view. F. Head, ventral view. G. Head, left lateral view. H. Epipharynx. I. Left mandible, dorsal view. J. Right mandible, dorsal view. K. Left maxilla, dorsal view. L. Labium, ventral view. M. Hypopharynx. N. Left maxilla, ventral view. O. Hypopharyngeal sclerite, highly magnified.

Pygopodia fairly well developed and usually seen as two conical processes below ninth segment. Spiracles circular, that on mesothorax the largest; first abdominal spiracle also somewhat larger than other abdominal spiracles. Legs (Fig. 11C) well developed, of about equal size and with reduced number of spines and setae; tarsungulus simple, fairly long, acute and with single ventral seta. Dorsal integument as in *P. capensis*, including the short spines and spicules. Length about 11 mm when fully grown.

Head (Fig. 11E–G)

Cranium nearly twice as wide as long, sides convex; shiny, somewhat shagreened, golden yellow; central transverse area darker, almost reddish brown in some specimens, including clypeus and labrum. Mandibles lighter in colour than rest of head. Coronal and frontal sutures clearly indicated, latter branched near antennal bases (apparently also the case in *Pachyphaleria capensis* and *Tribolium destructor*, but not as distinct as in this species). An elongate blackish eye-spot present behind antennal bases, but individual ocelli not demarcated in all specimens examined. Chaetotaxy as illustrated. Hind margin dorsally and ventrally only slightly emarginate in middle, postgenae separated by fairly well-indicated gula. Antennae as in *P. capensis*, second segment about one-third longer than first; third segment also small, less than one-third the length of second and bearing long apical seta.

Labrum and clypeus

Labrum about twice as wide as long and somewhat narrower than clypeus, its front margin almost straight, lateral margins convex. About ten slender setae present of which two are situated on central area and two in middle near anterior margin; also four short setae present along front margin. Clypeus as in *P. capensis*, slightly less than twice as long as labrum, with four setae on postclypeus.

Epipharynx (Fig. 11H). Rather similar to that of *T. destructor* (see Fig. 10J). Tormae symmetrical, posterolateral processes short and broad, median ones long and slender. Fine spine-like setae cover most of elongate area on each side of raised central part and forming an almost single row along front margin, the setae longer on tormae and along each side of central part, which bears six large sensilla and transverse posterior row of four smaller ones; behind these two spines present; also two longer spines or teeth present between posterior arms of tormae near transverse central bar, and just behind right tooth a row of about six longer spinules (or setae). Eight spines (or sensory spots) present on central area just behind long posterior teeth as well as one on left side between posterolateral process and median arms, and two in same position on right side. Three sickle-shaped setae present on each lateral margin of which the distal one is more strongly developed than others (rather similar to those of *P. capensis*).

Mandibles (Fig. 11I–J)

Similar to those of *P. capensis* (see Fig. 9M–N, U), fairly broad with flattened, almost triangular lateral face, bearing about six slender setae on its

upper and lower margins as indicated in drawing. Cutting edge bidentate on both mandibles with lower tooth (t_2) smaller than upper or apical one. Molar area with upper tooth (t_4) rounded on left mandible, but more acute on right one. Lower molar tooth (t_5) fairly acute on both mandibles. A small, distinct, rather acute tooth (t_3) present on trenchant ridge from upper scissorial to upper molar tooth, close to latter on left, but in about middle on right mandible (in both *P. capensis* and *T. destructor* this tooth is almost obsolete in left mandible).

Maxillae (Fig. 11K, N)

Similar to those of *P. capensis*, broad, mala with double longitudinal row of about nine spines on mesal side, dorsally beset with fine slender setae; ventrally devoid of slender setae. Stipes ventrally with three long setae of which one is situated near base, just anterior to cardo, which is fairly well indicated and without setae. Also small spine or spine-like seta present near mesal margin; dorsally stipes without setae, except one long and two short setae placed somewhat dorsolaterally. Maxillary palpi three-segmented, first two segments of about equal length, apical one somewhat shorter and with short subapical seta on mesal side and about twenty sensory pegs on apex; first segment with short dorsolateral seta near base and second segment with two very short ventral setae and one long lateral seta near apical border. Palpifer without setae and forming small, almost ring-like segment at apex (not observed in the specimens of the other two previously mentioned species).

Labium (Fig. 11L–M)

Submentum broad, oval, with two setae, one on each side near base of oval convex sclerite of cardo. Mentum longer than wide, somewhat barrel-shaped, its sides convex and bearing four setae on sclerotized posterior part. Prementum shorter than mentum with two long median setae near apex and short seta placed ventrolaterally; also minute spines posterolaterad of each median long seta. Glossa without setae as in *P. capensis*, ligula short, about three-quarters the length of first palpal segment and with two setae at apex. Labial palp two-segmented, first segment broader than long and somewhat longer than apical conical segment and with two short ventral setae near apical border one mesally and one laterally; second segment with about twenty sensory pegs at apex.

Hypopharynx (Fig. 11M, O). Medially raised, the hypopharyngeal sclerite appearing cup-shaped; however, when viewed slightly from the side its dorsal aspect is an almost inverted horseshoe-shaped sclerite with a somewhat dome-shaped ventral side.

Pupa (Fig. 12A, C–D)

Rather similar to that of *Tribolium destructor* (see Fig. 10Q–R) but larger, measuring 6,6 mm long and 2,7 mm broad and lacking the long setae on pronotum; latter broad, about twice as wide as long (in *T. destructor* only slightly wider than long). Head, pronotum, wing-covers and pleural surfaces with some

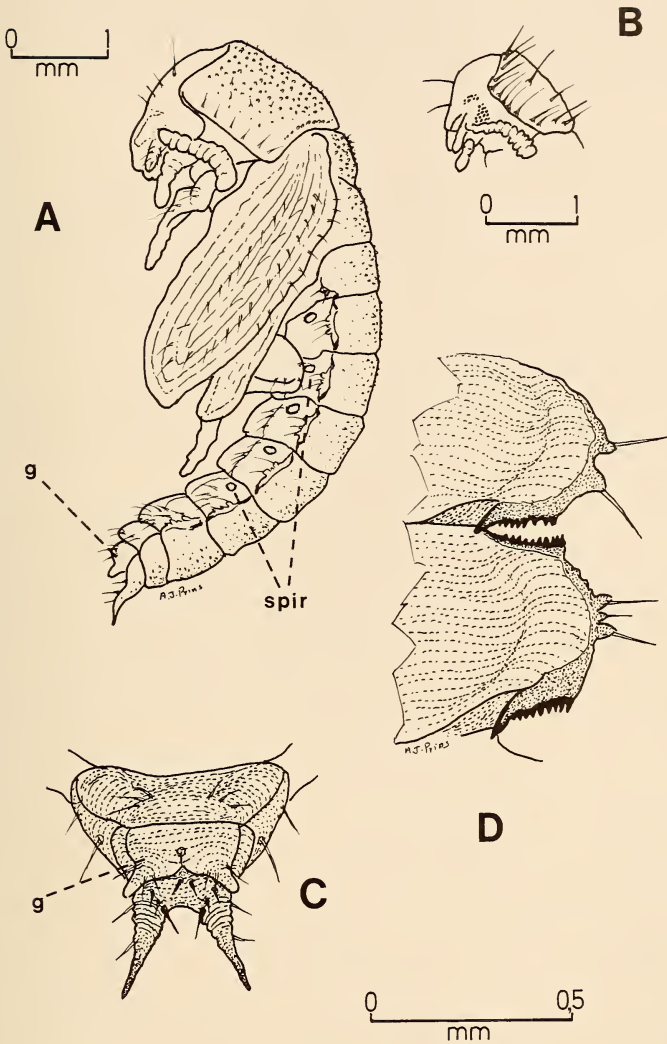


Fig. 12. Tenebrionidae. A. Pupa of *Alphitobius diaperinus*, left lateral view. B. Head and pronotum of pupa of *Tribolium destructor*, left lateral view. C-D. Pupa of *Alphitobius diaperinus*. C. Abdominal apex, ventral view. D. Comb-like structures on first two abdominal segments, dorsal view.

fine setae, also some setae present on legs and mandibles. Thorax and abdominal terga covered with minute tubercles, those on thorax larger than the others (in *T. destructor* the body surface is more shagreened or wrinkled). Spiracles similar to those of *T. destructor* and *P. capensis*, six pairs clearly visible, seventh pair indistinct. Developing genital capsule and lateral extensions of abdominal terga including anterior and posterior teeth similar to those of *T. destructor*; however, the dentate areas more elongate.

BIOLOGY

The genus *Alphitobius* belongs to the subfamily Ulominae, the members of which are mostly detritivorous. Only about ten species of this genus occur in the Subsaharan region, one, *A. leleupi* Koch, being commonly found in the nests of gerbilles (*Tatera* species—Koch 1953). As far as is known only four members have been recorded from southern Africa, viz. *A. hobohmi* Koch from South West Africa, *A. karrooensis* Koch from the Cape Province, *A. ulomoides* sensu Koch (nec *ulomoides* Solier, which is a native of Chile), and the widespread *A. diaperinus*, which has become a pest of stored grain and flour. However, according to Cotton (1941) it does not damage sound and dry grain. There is also a possibility that this latter species plays a role in the transmission of acute leukosis in chickens (Eidson *et al.* 1965).

The lesser meal-worm *A. diaperinus* often occurs, together with skin-and-hide beetles, during the third or dermatophagous stage of decay of carcasses and cadavers and is commonly found in fowl manure, particularly in the closed-type poultry batteries with a fairly high and constant temperature of about 20 °C. Where very large populations of this beetle and of *Dermestes maculatus* occur the beetles compete with the normal fly species to such an extent that such poultry houses are almost free of the common house-flies, false stable-flies and lesser house-flies. Under these circumstances larvae of the skin-beetle may become troublesome in their effort to secure suitable space for pupation and may cause severe damage to roof timbers, door frames, etc. Application of an insecticide such as carbaryl in a broad band around the inside walls and the floor adjoining the walls of the building has controlled the wandering larvae of this pest in the past, whilst allowing the meal-worm larvae to continue feeding in the manure; however, large populations of the latter may have a depressing effect on hens kept on floor litter. When crowding occurs in the case of large populations larvae of both species become predacious and even cannibalistic. Young larvae are preyed upon by the histerid *Carcinops minuta* (Fåhræus), breeding in the manure.

Fairly young larvae of the lesser meal-worm collected on a decaying turtle carcass during February lived for at least 30–40 days in the laboratory and moulted several times before pupation occurred; the pupal stages lasted for about 10 days (temperature about 25 °C). According to Barké & Davis (1969) the pupal stadium was 7–11 days at about 21 °C and 70 per cent relative humidity, and the total life-cycle 69–91 days; the eggs hatched over a period of 6–10 days. Cornwell

(1973) gives the minimum development period as 40 days at 25 °C. When freshly formed, the pupae are creamy white but later change to a darker colour. The newly-emerged beetles are pale brownish-white and assume their normal colour in a day or two.

SERIES SCARABAEIFORMIA

Family **Scarabaeidae**

Small to large, usually stout-bodied or robust beetles, sombre to brightly coloured with partly deflexed head and antennae with lamellate club of three to seven segments; elytra usually exposing pygidium; wings well developed, absent in some forms such as certain dung-rollers and trogids (the latter often regarded as a separate family, Trogidae). Head and pronotum often with horn-like processes; front tibiae fossorial; tarsal formula 5-5-5.

This is a large family composed of two groups. In the first at least four subfamilies are involved and the members are either saprophagous or fungivorous. This group includes the true dung-beetles or dung-rollers of the subfamily Scarabaeinae (Coprinae) in which the adults have eight- to nine-segmented antennae and the larvae have a distinct dorsal hump (Fig. 19C). Their legs are usually reduced or the claws are absent. Both adults and larvae are found in dung and carrion and the adults may even feed on fungi. This subfamily includes fairly large and robust beetles, having a body length of up to 57 mm in Subsaharan forms, such as *Heliocopris gigas* (Olivier), ranging from Zimbabwe to tropical Africa. It also includes the flightless, ball-rolling *Circellium bacchus* (Fabricius), which has been recorded from the Cape Province, Transvaal, and Mozambique (Ferreira 1967) but according to Tribe (1978) is now restricted to the eastern Cape Province, particularly the Addo Elephant Park, and may be heading for extinction. It is most probably a forest-bound species and may still be present in fair numbers in such localities in Mozambique, Transvaal, and the north-eastern parts of southern Africa.

Some of the smaller members of this subfamily such as the widely distributed, bronze-and-green dung-beetle, *Onitis aygulus* (Fabricius), and the black *O. caffer* Boheman do not roll balls but burrow into the soil beneath animal droppings and utilize the contents below the crust of the cow-pats for oviposition. These are strong fliers and powerful diggers and prefer fresh dung, particularly during the winter months.

Three species of the smaller genus *Euoniticellus* were collected from fresh dung during the surveys: *E. intermedius* (Reiche), *E. triangulatus* (Harold) and *E. africanus* (Harold), of which the first two occurred in large numbers almost throughout the year in most of the areas visited. The indigenous *E. africanus* (Fig. 14F) was only occasionally encountered, usually in the Montagu area and along the south coast during the summer and late spring. These beetles are dark brown with black marks and spots on their bodies, and vary in length from 7-10 mm in *E. intermedius* and *E. triangulatus* to 10-11 mm in *E. africanus*.

Oniticellus pictus (Hausmann) (Fig. 18A) and *O. planatus* Castelnau (Fig. 19A) also visit fresh dung, as their pupal cells were often found in large numbers in semi-fresh pats in the Robinson Pass and near Mossel Bay during the autumn. *Oniticellus pictus* resembles the members of the genus *Euoniticellus*, but is easily separated from them by the clearly demarcated black marks on its body. Both *O. pictus* and *O. planatus* were found in the same pats.

Chironitis scabrosus (Fabricius) was very common near Montagu and in the Karoo during the summer. This beetle is medium-sized, castaneous or testaceous brown with a bronzy tinge, having the pronotum with irregular rugae and the elytra with blackish tubercles. In fresh cow-pats it was usually associated with *C. hoplosternus* (Harold), which is rather similar, but has the pronotum somewhat wider, is more greenish and is without the rugosity.

The black species of *Copris* and *Onthophagus* were observed in small numbers on fresh dung in various localities during the spring and winter, *Copris anceus* Olivier (Fig. 13A) being the most common. Males of *C. anceus* (19–20 mm long) have a triangular horn on the head; females, which are somewhat smaller, have the pronotum slightly convex, without horns and the head with only a short tooth-like horn.

Onthophagus minutus Hausmann (about 6 mm long), black in colour, with a short tooth-like horn on the head of the male, was occasionally seen feeding on fresh and semi-fresh dung near Mamre and other Sandveld areas. Another species, *O. immundus* Boheman (matt black and 5–5,8 mm long), was frequently found in Heidelberg during the spring and summer. The males are easily recognized by two parallel horns on the head. In this area it was associated with the much larger (9–12,6 mm) *O. binodis* Thunberg (Fig. 14A–B), also matt black. Males of the latter have a rectangular, carinated, raised lobe in the middle of the pronotum. This species also occurred commonly in the Karoo during the autumn. *Onthophagus cameloides* D'Orbigny (Fig. 13E), dull black and about 10 mm long, appeared in partly dry dung in the western and northern parts of the Cape Province, but was not numerous.

A rather peculiar, dark-brown scarab, *Drepanocerus kirbyi* Kirby (Fig. 14D), about 6 mm long with three long horns, one on the head and two on the pronotum, seems to be fairly common in the Robinson Pass where it was found feeding on fresh dung on several occasions during the summer and autumn months. The large, shiny black dung-roller, *Neateuchus proboscideus* (Guérin) (Fig. 14G) (almost 30 mm long), on the other hand, was collected only occasionally during the spring in the north-western parts. Other small scarabs belonging to this subfamily, found in fresh to semi-fresh cow-pats, were the greenish-black *Epirinus aeneus* (Wiedemann) and the larger, blackish *E. flagellatus* (Fabricius) (Fig. 13D), both endemic to the Cape according to collection data.

The small dung-beetles of the subfamily Aphodiinae include the regular inhabitants of herbivore droppings that never bury any dung but feed on it as long as enough food is available. The larvae of these coprophagous beetles with their

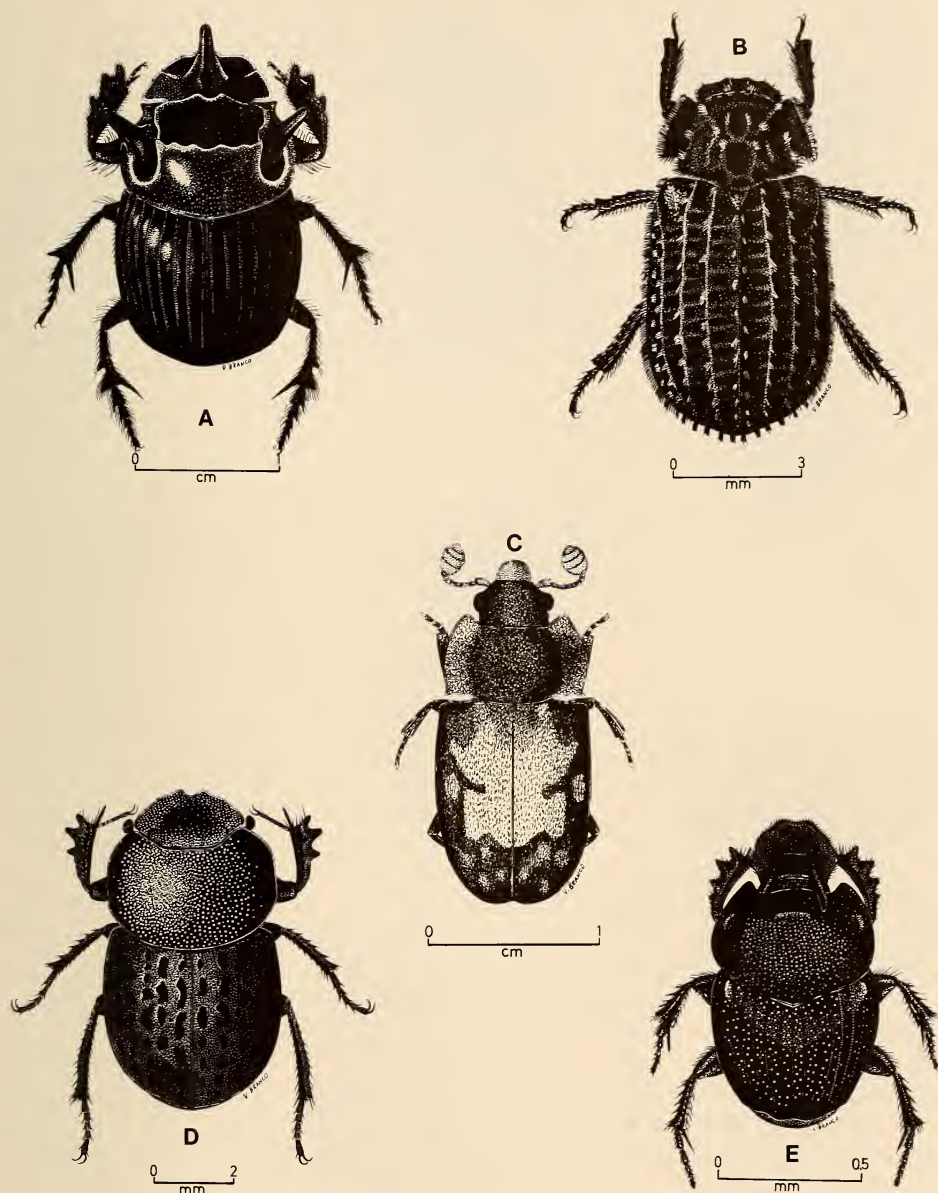


Fig. 13. Scarabaeidae. A. *Copris anceus*. B. *Trox fascicularis*. C. Unidentified species of Trogositidae. D. *Epirinus flagellatus*. E. *Onthophagus cameloides*.

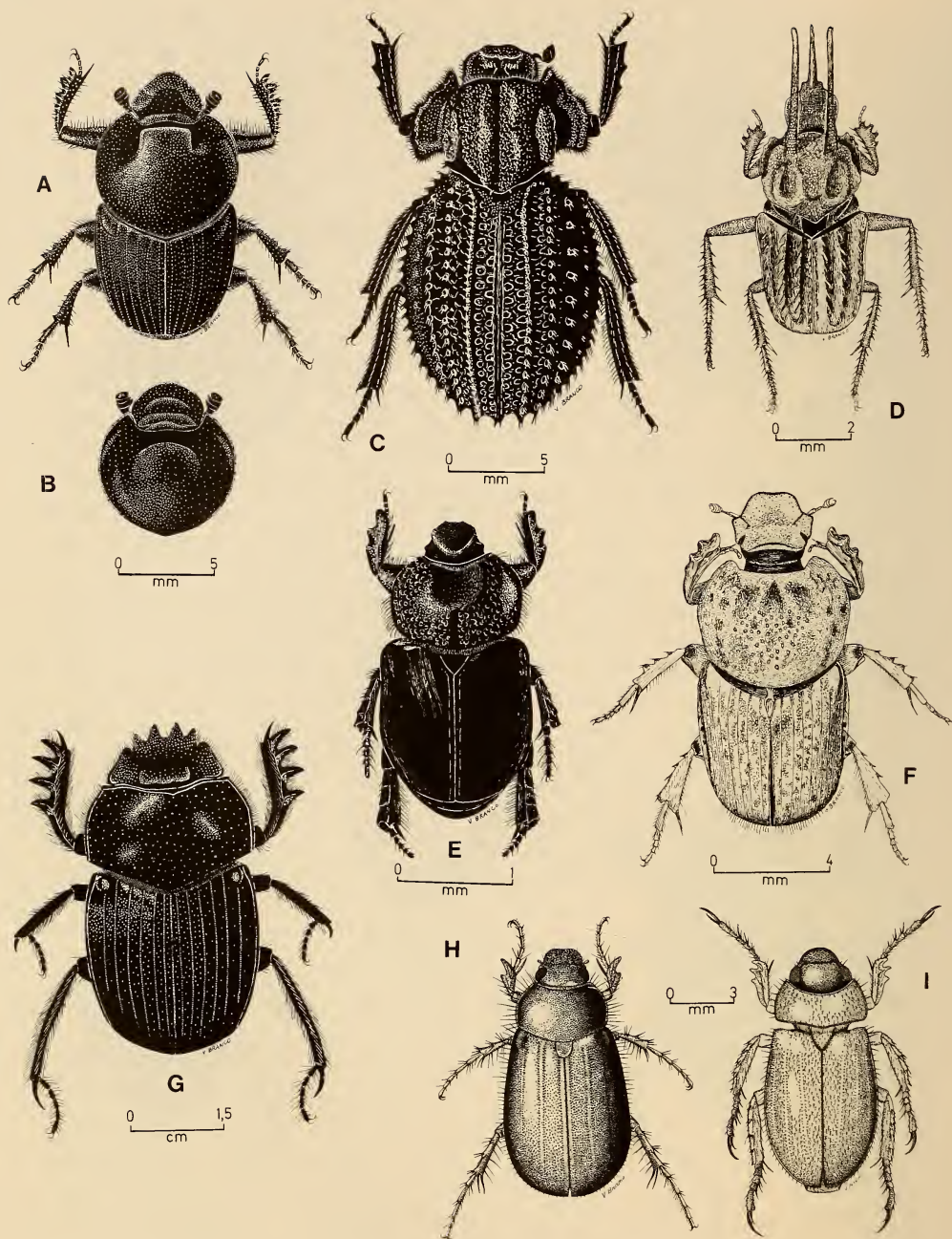


Fig. 14. Scarabaeidae. A. *Onthophagus binodis*, ♂. B. *Onthophagus binodis*, head and pronotum of ♀. C. *Trox horridus*. D. *Drepanocerus kirbyi*. E. *Temnorrhynchus retusus*. F. *Euoniticellus africanus*. G. *Neateuchus proboscideus*. H. *Eucamenta castanea*. I. *Adoretus ictericus*.

well-developed mouth-parts are able to feed on even fairly dry dung particles, whereas in the case of the adults, as in other smaller members such as the previously mentioned genus *Oniticellus*, the mouth-parts are more membraneous and they are therefore compelled to feed on moist or soft dung. This is also substantiated by their intestinal contents which generally only contain soft liquid compounds.

In the adults the antennae are usually nine-segmented with three-segmented club and the larvae have well-developed legs and lack the dorsal hump. A few species are phytophagous (not present in South Africa) and at least two species, *Aphodius lividus* (Olivier) and *A. granarius* (Linnaeus) (both present in South Africa), are cosmopolitan.

Some 150 species of aphodiines have been recorded from southern Africa of which about ninety-six belong to the genus *Aphodius*. These small scarabs are rather important as they play a vital role in the disposal of animal dung in the veld. During the surveys at least ten species were found to be attracted to fresh droppings, and some used the dung as food. *Aphodius procerus* Harold, *A. consimilis* Boheman and *A. laetus* Wiedemann were found to be truly coprophilous, actually breeding in this medium; *A. consimilis* and *A. badius* Boheman were found even after the droppings had dried out to some extent. *Aphodius badius*, which is rather similar to another small, dull, dark-brown scarab *Drepanocanthus lineatus* (Wiedemann), but much smaller, has in addition been collected in fresh dung on the beach along the west coast of the Cape Province together with the previously mentioned *Epirinus aeneus*.

Most of the *Aphodius* species are widely distributed: *A. procerus* (Fig. 16A) and *A. maculicollis* Reiche occurred more commonly to the east of the Cape Peninsula and in the Karoo, while *A. hepaticus* Roth was found only in June in fresh dung in the Little Karoo. All the other species occurred almost throughout the year, *A. consimilis* being particularly abundant during the early spring. This species is often attracted to lights in houses, especially during the late summer and autumn.

The larvae of *A. laetus* and *A. procerus* were fairly heavily preyed upon during the winter and early spring by the larvae of a black and white-banded dextiid, *Pretoriamyia sellifera* van Emden, which occurred throughout the survey area. The larvae of an unidentified muscid of the genus *Helina* were also responsible for the destruction of various small scarab grubs, mostly *Aphodius* species, and it seemed to have the same habits and distribution as the species of *Pretoriamyia*.

Puparia of *Helina* spp. can easily be separated from those of *Pretoriamyia* by the small pale posterior spiracles placed close together at the hind end. In *Pretoriamyia* the spiracles are larger and black and situated on the dorsal side of the hind end.

Another aphodiine found in large numbers in fresh dung is the above-mentioned *Drepanocanthus lineatus*. It was collected in almost all areas during winter and spring; in the northern parts it appeared together with *Coptochirus excisus* Harold, which is much smaller and more shiny. Along the south coast it was found in association with *Harmogaster intrusa* (Peringuey) a small, dull,

dark-brown species with black pronotum. *Coptochirus pallidipennis* Harold, and *C. brachypterus* Harold, were found to be very numerous in the Mamre area during September when large numbers of both were seen to copulate. *Coptochirus emarginatus* (Germar), a very common species in fresh and partly fresh dung all along the west coast almost throughout the winter and early spring, often occurs in large numbers in factories manufacturing materials that contain feathers, such as quilts.

All the *Coptochirus* species mentioned here are small (4,6–5 mm long), and are recognized by the emarginate anterior border of the head. *Coptochirus emarginatus*, *C. pallidipennis* and *C. excisus* are light brown, with the pronotum and head a darker brown in the middle. The first-named species also has dark-brown patches on the elytra. *Coptochirus brachypterus* on the other hand has the pronotum and head almost black in the middle and the elytra in the specimens examined are darker than in the other three species.

A large number of small scarabs were still present in partly dry cow-pats that were examined and of these the following were found to be prevalent: *Aphodius moestus* Fabricius, *A. bidentulus* (Harold), *A. lugubris* (Boheman), *Oniticellus pictus*, *Coptochirus pallidipennis*, *C. brachypterus*, *Onthophagus cameloides*, *Harmogaster exarata* Harold, the two scarabaeines, *Odontoloma dentinum* (Harold) and *O. pygidiale* Peringuey, *Aphodius discoidalis* Boheman and sometimes also *A. badius*, *A. rubricosus* Boheman, and the black maize-beetle, *Heteronychus arator* Burmeister (subfamily Dynastinae). The last two species even occurred when the pats were very dry and their crust hard and firm, while *A. moestus* also bred in fresh and semi-fresh pats.

All the *Aphodius* species are more or less dark brown, but *A. moestus* (Fig. 15E) has lighter elytra, marked with short, longitudinal, black stripes. It is widely distributed in South Africa and its larvae are most often found in association with those of *A. consimilis*. *Aphodius lugubris* on the other hand seems to be more restricted to the west coast and appears in rather small numbers throughout the spring and autumn; it is commonly found to breed in the decaying reeds in thatched roofs of houses and rondavels. The shiny-brown *Aphodius discoidalis*, almost of the same size as *A. moestus* (about 7 mm), was collected in fairly large numbers near Melkbos during March, whereas *A. bidentulus* (4,5–5 mm long), which is slightly shiny and black, was found in the Heidelberg area of the Cape Province during the early winter in semi-fresh to almost dry cow-pats.

Oniticellus pictus, already mentioned in connection with fresh dung, was collected in almost dry pats near Hermanus and further east along the south coast. *Oniticellus militaris* Castelnau (about 9 mm long, dull dark brown, with rather indistinct black markings on the elytra), was found to be common in the autumn in semi-fresh and also fairly fresh cow-dung near Mossel Bay and in the Robinson Pass. *Coptochirus pallidipennis* and the almost black *Harmogaster exarata* were occasionally found in very large numbers in fairly fresh as well as in partly dry dung in most of the areas investigated. The latter is easily distinguished from *C. pallidipennis* by the structure of the striae on its elytra. Of the species

invading fresh dung, *Aphodius consimilis* and *A. procerus* together with *Onitis caffer* remained in the dried-out dung for fairly long periods.

Odontoloma dentinum (3,4 mm long), dull black in colour with striae similar to those of the previously mentioned *Onthophagus cameloides*, and *Odontoloma pygidiale*, similar to *O. dentinum*, but lacking the longitudinal, smooth line on the anterior part of the pronotum, were collected together with other small scarabs in semi-fresh dung near Stilbaai during the autumn and near Elands Bay during midwinter. Both species seem to be restricted to the southern part of southern Africa according to collections that were made in the past.

Usually the larvae of only one species were found in a single cow-pat; in the case of *Aphodius laetus*, *A. moestus* and *A. consimilis*, however, the larvae were collected in the same pats.

The other two smaller subfamilies belonging to this group of scarabs, the Geotrupinae (with three tribes of which only one, the Bolbocerini with about forty species, is represented in southern Africa) and the Troginae (with one Subsaharan genus comprising forty-two southern African species), are often placed as separate families.

Only three trogids were collected during the surveys, the largest being the previously mentioned *Trox horridus* Fabricius (Fig. 14C), 17–18 mm long with penicillate tubercles as well as serrate lateral margins. It was often observed during the winter months on or in the vicinity of dry cow-pats near Saldanha. It differs from *T. fascicularis* Wiedemann (Fig. 13B), which was occasionally attracted to partly-fresh dung, by its size and by the absence of wings. This latter species is also dull black and widely distributed in the Cape Province and Natal. Another small species, *T. rhyaroides* Harold, occurred only in decaying carcasses. The larvae of one of the largest members of this subfamily, *T. procerus* Harold, not present in southern Africa, but widely distributed in the arid parts of north Africa and Arabia, have been observed by Van Emden (1948) to feed on the eggs of the desert locust, *Schistocera gregaria* (Forskål) in Somalia.

The second group of scarabs includes the major phytophagous members, better known as chafer-beetles, cockchafers, June beetles, Christmas beetles, monkey-beetles, fruit-beetles and rhinoceros-beetles. Some of them often swarm in large numbers during the spring, defoliating fruit and forest trees; a few species, however, are predacious. The larvae are typically scarabaeiform as in the first group, C-shaped (except in certain members such as the fruit-beetles), whitish, with well-developed legs increasing in length from front to back, and with pale reddish-brown head, either with or without ocelli. They are known as white grubs and feed on dung, other decaying organic material, or on the roots of plants, and may cause severe damage to cultivated crops and lawn grass.

The rhinoceros-beetles (subfamily Dynastinae) contain about sixty southern African species, mostly dark brown to black in colour, with ten-segmented antennae. The most common and widespread member is probably the shiny

dark-brown *Oryctes boas* (Fabricius), 35–40 mm long, with a long curved horn on the head of the males. One of the largest Subsaharan species is *Dynastes centaurus* (Fabricius), measuring about 55 mm long and occurring also in the north-eastern parts of South Africa. (Males of the large Hercules beetle *D. hercules* (Linnaeus) of Central America and the West Indies measure up to 130 mm, including the horn.)

In the larvae of this subfamily, which generally feed on roots or other decaying vegetable matter, the labrum is usually asymmetrical and the ninth and tenth abdominal terga are completely fused (Crowson 1967). This is apparently not the case with all the members of this subfamily (see description of the larva of *Temnorrhynchus retusus* (Fabricius), p. 290). In the case of the previously mentioned black maize-beetle, *Heteronychus arator*, commonly found under semi-dry to dry cow-pats, the larvae do very little damage; the adults, however, may cause severe damage to young maize plants, trees, etc., and even lawn grass. The larger *H. licas* (Klug), widely spread in the Subsaharan region, including the north-eastern parts of South Africa, often causes considerable damage to maize and sugar-cane in Mozambique (Jerath 1966), and in this case both larvae and adults are responsible. *Heteronychus consimilis* Kolbe, which is of about the same size as the black maize-beetle, is a serious pest of wheat in Kenya (Le Pelley & Goddard 1952); according to collection records it does not occur in South Africa. The larvae of a few species are found in termite mounds and feed on the material of which the mounds are made.

A regular visitor on the open beach along the west coast is the piceous-red *Temnorrhynchus retusus* (Fig. 14E), rarely seen because of its habit of burrowing into the sand, most often just above the low-water line. Larvae of this species feed on plant roots and other organic matter and are common in sandy soils throughout the year in certain parts of the Cape Peninsula. It is also present on Dassen Island. The larvae of a related species, *T. coronatus* (Fabricius), somewhat bigger than *T. retusus* (about 23 mm long) and widely spread in the Subsaharan region including South Africa, sometimes damage the underground parts of strawberry plants (Oberholzer 1963).

Some 270 species of fruit-beetles (subfamily Cetoniinae) have been recorded in southern Africa, the largest members found in the Republic of South Africa being the black and light-grey *Goliathus albosignatus* Boheman (45–55 mm long) and the green and white *Dicranorrhina derbyana* Westwood (35–50 mm long). This subfamily includes the large, robust, maroon-coloured Goliath beetle *Goliathus goliathus* (Drury), of tropical Africa, which may reach a length of 90 mm or more.

The larvae of these beetles usually feed on humus, particularly in compost heaps, dead logs, etc., and are not curled like the other scarabs, but are able to stretch their bodies and walk horizontally or even slide in a worm-like motion on their backs. The ninth and tenth abdominal terga are completely fused as in the dynastids, but the labrum is always symmetrical (Hayes 1929).

The adults, with ten-segmented antennae, are diurnal and usually feed on nectar. Members of the genera *Pachnoda* and *Rhabdotis* are particularly fond of ripening fruit and may cause considerable damage in orchards. The genus *Rhinocoeta* includes three species that generally fly at night and are coprophagous. *Rhinocoeta cornuta* (Fabricius) is the most wide-spread, its larvae being common in partly fresh cow-pats along the south coast. Another typical member is *Trichostetha fascicularis* (Linnaeus), about 23 mm long with green elytra and black prothorax having four thin white longitudinal lines. It is common in proteas, particularly the king protea (*Protea cynaroides*), often in association with the smaller brownish *T. capensis* (Linnaeus), the larvae of which are also known to cause destruction to thatched roofs in the Cape Peninsula, and *T. signata* (Fabricius) whose larvae are occasionally found in dassie dung in the same area. The larvae, when full grown, construct a fairly hard earthen cocoon in which the pupae are formed. Immature stages of *T. capensis* have been observed in the mounds of termites (*Termes* spp.), sometimes together with those of the large dark-brown dynastid, *Pseudocyphonistes corniculatus* (Burmeister) (adults 30–40 mm long). They both feed on the material of which the mounds are made. The larval stage of some species, such as the brownish-yellow and black to piceous *Stripsiphier zebra* Gory & Percheron, is usually spent in rotten logs; however, they are often found causing considerable damage to thatched roofs, as in the case of the above-mentioned *Trichostetha capensis*. Some members of the tribe Trichiini, such as *Agenius limbatus* (Olivier), are often found under completely dry cow-pats.

The tribe Cremastochilini contains several members which are either found in birds' nests, in ants' and termite nests, or occur in beehives. At least two species, *Pseudospilophorus plagosus* (Boheman), shiny black with two large whitish marks on the elytra as well as an oblong whitish mark near the elytral apices, and about 12 mm long, and *Brachymacroma emarginicollis* (Boheman), of about the same length and black with large yellowish patches, are predacious, feeding on the yellow aphid, *Aphis nerii* Boyer de Fonscolombe, on milkweed plants (*Asclepias* spp.) (Skaife 1953). *Pseudospilophorus lugubris* (Fabricius), similar to *P. plagosus*, but lacking the distinct oblong mark on the elytral apices, often occurs in the nest of the social spider (*Stegodyphus* sp.) of the family Eresidae.

According to Peringuey (1907) the species of *Pseudospilophorus* breed in the nests of small birds such as finches, etc., feeding in both the larval and adult stage on the faeces of the young birds. This also applies to the large, shiny, black hive-beetle, *Diplognatha gagates* (Forster) (18–30 mm long—tribe Diplognathini), the larvae of which construct a fairly hard earthen cocoon in which pupation occurs, as is the case with the above-mentioned species.

Members of the genera *Hoplostomus*, such as the shiny black *H. fuliginosus* (Olivier), a typical cetoniid (about 23 mm long), and *Goniochilus*, particularly the black and dark-red *G. bicolor* Harold (about 22 mm long), are often attracted to beehives where they feed on the honey. The shiny-black *Genuchus hottentottus* (Fabricius), about 10 mm long, on the other hand, is commonly found in the

flowers of the sugar-bush (*Protea repens*), feeding on the nectar, and occasionally appears in the carton nests of the cock-tail ant, *Crematogaster peringueyi* Emery, in the Cape Peninsula. The reason for their presence in the ants' nest is still unknown, but from observations it seems certain that they are treated as persecuted synoeketes.

Species belonging to at least six genera of the tribe Cremastochilini have been observed to be myrmecophilous or termitophilous, most of them apparently being treated by the hosts as persecuted synoeketes as in the case of the species belonging to the genus *Genuchus*. *Coenochilus*, the biggest genus of this particular section, includes about sixteen southern African species, most of which are fairly widely distributed. Peringuey (1907) particularly mentions the large, dark-brown *C. hospes* Peringuey (about 24 mm long) from the mounds of the large fungus-grower termite, *Odontotermes transvaalensis* (Sjöstedt). Another member, the dark-brown *Trichoplus aegyptus* Kolbe, often occurs in the mounds of the harvester termite *Microhodotermes viator* (Latreille) in Namaqualand.

Adults of about seven species were found to occur in the nests of the pug-nacious ant, *Anoplolepis custodiens* (Smith), viz. *Trichoplus vicinus* Peringuey, *T. schaumii* Westwood, *Plagiochilus diversus* Peringuey, *P. intrusus* Peringuey, *Scaptobius capensis* (Gory & Percheron), *Placodidus compransor* Peringuey, and *Myrmecochilus marshalli* Wasmann. They are all flattened, dark-brownish beetles, about 9 mm long, except the last which is about 15 mm long and black with a whitish band along the sides of the body. Species of the genus *Trichoplus* mentioned above are easily recognized by their very concave prothorax. *Coenochilus appendiculatus* Gerstaecker was apparently found in the nest of the black sugar-ant, *Acantholepis capensis* Mayr, according to Schein (1954), as well as in the mounds of a large fungus-grower termite (*Macrotermes* sp.).

The subfamilies Rutelinae and Melolonthinae include the chafer-beetles or cockchafers and monkey-beetles. Both subfamilies are well represented in southern Africa and contain species of economic importance.

In the Rutelinae, with about a hundred southern African species, the adults have nine- to ten-segmented antennae and in the larvae the ninth and tenth terga are distinct. In this case the anus is not angulate in the middle. At least about seven species are harmful, including the maize-chafer beetle *Chaetoderus cribrus* (Harold), the pecan-beetles *Anomala probativa* Peringuey and *Adoretus laticeps* Fåhræus, the two wattle-chafers *Anomala caffra* Burmeister and *Adoretus ictericus* Burmeister (Fig. 14I), and sometimes also *Adoretus tessulatus* Burmeister, which feeds at night on rose leaves (Smit 1964). *Adoretus ictericus* is often attracted to sites of decaying carcasses, mostly during the late ceratophagous stage when the soil is enriched with organic matter; in this case their larvae have on various occasions been recovered from the soil under the carcasses.

Nearly 900 species of melolonthids occur in southern Africa, some of the largest South African members being the dark-brown species, *Macrophylla*

pubens Peringuey (about 27 mm long) and *M. maritima* Burmeister (about 33 mm long), both from the southern and eastern Cape Province. The adults of these beetles have nine- to ten-segmented antennae and in the larvae the ninth and tenth terga are also distinct; the anus, however, is angulate in the middle in this case.

The larvae of at least five species of *Macrophylla* cause severe damage to golf- and bowling-greens in the eastern Cape Province. In Zimbabwe the large brownish *Eulepida mashona* Arrow (about 25 mm long), with short decumbent hairs giving it a greyish appearance, is regarded as a pest of maize, whereas the smaller (about 15 mm long) shiny, dark-brown *Schizonycha profuga* Peringuey, of the same distribution, damages tobacco plants. According to the collection data they do not occur in South Africa. *Eucamenta castanea* (Boheman) (Fig. 14H), very similar to *S. profuga* and of about the same size and colour, is sometimes attracted to decaying carcasses in the Cape Peninsula together with *Adoretus ictericus* during the last post-mortem stage; its larvae, however, have never been recovered under such circumstances.

The most abundant melolonthids are the monkey-beetles (tribe Hopliini), which are mostly attracted to flowers, particularly burrowing in yellow and white flowers of the family Compositae. One of the most common in the western Cape is the hairy black *Anisonyx ursus* (Fabricius), which is about 10 mm long. These beetles are usually very abundant for a short while during the spring, but then disappear until the following spring. They are easily recognized by the enlarged and long hind legs, especially of the males. Adults of most of the species are often attracted to decaying matter. However, very little is known about their life-cycle: it is probably the same as that of the small wattle-chafer, *Monochelus calcaratus* Burmeister (see Prins 1965). Some of the largest members of this tribe are the dark-brown *Hoplocnemis hylax* (Fabricius) and *H. spectabilis* Peringuey of the eastern Cape Province, and *H. koikoina* Peringuey of Namaqualand (males of all these species about 15 mm long).

Aphodius laetus Wiedemann

DESCRIPTION

Adult

Previously described by Peringuey (1901). Very similar to *Aphodius procerus* (Fig. 16A) but smaller, being 6.6–8.3 mm long. Head and pronotum dark brown to almost black; elytra lighter, yellowish brown to flavous; moderately shiny.

Widely distributed in the Cape Province; also found in Natal and Senegal (Schmidt 1910).

Larva

Mature larva 9–10 mm long. Whitish to bluish white with semi-matt, brown head; frons pale brown to almost yellowish and *A. laetus* is therefore easily recognizable. Overall shape like that of *A. procerus*, but smaller. The thoracic

spiracles oblong and somewhat larger than others; area in front of spiracle very convex. Abdominal segments 1–6 with three annulets, segments 7–8 with two annulets. Each annulet with a row of fine hairs; those on segments 2–5 short and spine-like in older specimens. Legs sparsely covered with hairs, basal half of coxae almost devoid of hairs. Claws simple and more distinctly demarcated than in *A. procerus* (Fig. 15N).

Head (Fig. 15I)

Epicranial suture distinct. Frons lighter coloured than rest of head, with four anterior frontal and four posterior frontal setae, both forming two curved rows. Mesal side of frons near base also with setae, as in *A. procerus*. Epicranium darker than frons, as already stated, and with four to six lighter spots, each with a long seta. Lateral sides of epicranium with numerous short setae. Antennae with four large movable segments and a small fifth segment bearing sensilla. Setal pattern very similar to that of *A. procerus*, except for very small setae on epicranial sides.

Labrum and clypeus

Labrum slightly shorter than clypeus, the two clithra clearly visible dorsally. Median row of four long setae present; posterior to this row are two shorter setae, just in front of clypeal border. Median lobe dorsally with two long setae as well as four strong setae on extreme anterior border as in *A. procerus*. One long and two short setae also present laterad of each clithrum on lateral lobes. Clypeus about 1.25 times the length of the cranium, with one long and one short seta on each side of postclypeus, as well as two shorter paramedian setae.

Epipharynx (Fig. 15K) very similar to that of *A. procerus*, but each acanthoparia consisting of only four setae, of which one is situated in front of each torma as in latter species. Tormae fairly symmetrical and central area of pedium also similar to that of *A. procerus*, but distal section of hairs flanking anterior part of epitorma, more strongly developed than rest of hairs and much more pronounced.

Mandibles (Fig. 15P)

Rather similar to those of *A. procerus* (Fig 16K), but neck of mandible in region of scissorial teeth (t_2 and t_3) and molar area wider and only two setae visible on exterior margin in specimens examined. Scrobis on each mandible indistinct and dorsal carina rounded and weak. First molar tooth (m_1) narrower than in *A. procerus* and straighter; transverse groove on right molar area almost obsolete; ventral section of molar area of right mandible forms separate piece between m_3 and m_4 , which is not so pronounced in *A. procerus*. Stridulatory area absent on both mandibles. Dorsomolar setae (xy) on both mandibles similar to those of latter species.

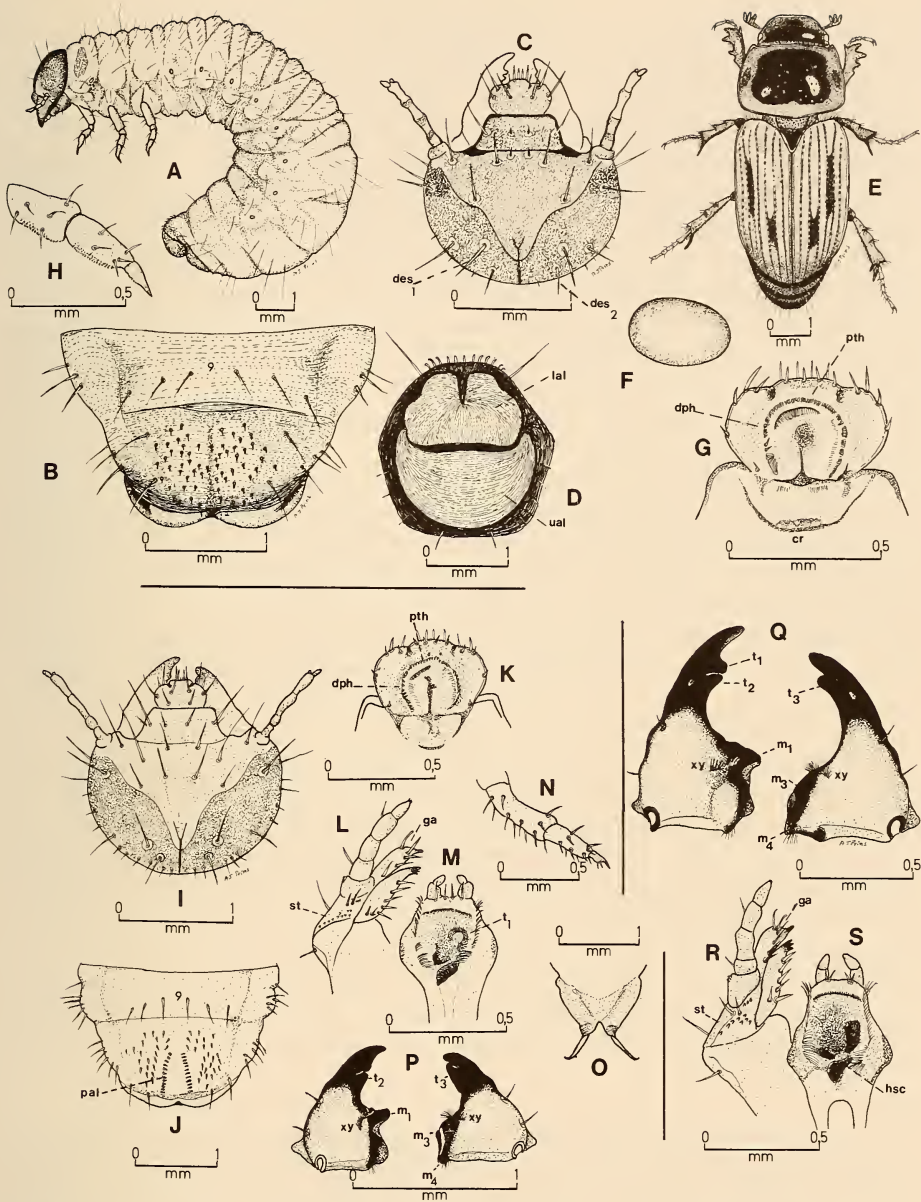


Fig. 15. Scarabaeidae. A-H. *Aphodius moestus*. A-D. Larva. A. Left lateral view. B. Apical abdominal segment, ventral view. C. Head, dorsal view. D. Anal opening, viewed directly from the rear. E. Adult. F. Egg. G-H. Larva. G. Epipharynx. H. Right mesothoracic leg. I-P. *Aphodius laetus*. I-N. Larva. I. Head, dorsal view. J. Apical abdominal segment, ventral view. K. Epipharynx. L. Left maxilla, dorsal view. M. Hypopharynx. N. Right mesothoracic leg. O. Pupal hooks, ventral view. P. Mandibles, dorsal view (larva). Q-S. *Aphodius moestus* larva. Q. Mandibles, dorsal view. R. Left maxilla, dorsal view. S. Hypopharynx.

Maxillae (Fig. 15L)

Very similar to those of *A. procerus*; the galea free for most of its length. Latter with a single tooth and five setae on dorsal side; ventrally with longitudinal row of eleven to twelve strong setae, situated close together (as in *A. procerus*), as well as single seta close to uncus. Lacinia ventrally with two setae of which apical one is strong and tooth-like and situated near the three unci. Mala dorsally with seven strong setae. Stipes with two dorsal setae and row of eight to eleven small stridulatory teeth. Also two to three teeth near border of palpifer, which has no teeth, but some papillae on its exterior border. Labacoria dorsally bare, but with three setae on ventral side. Stipes also ventrally with one distal and one proximal seta; latter located near border of galea. Palpifer and first segment of maxillary palp each with long ventral seta; penultimate segment also with one ventral and one external seta. Alacardo with one seta.

Labium

Very similar to that of *A. procerus*, distal sclerite of prementum as well as proximal sclerite each with two long setae; postmentum with one or two setae on each side; also two setae close together near anterior margin of distal sclerite of prementum.

Hypopharynx (Fig. 15M) very similar to that of *A. procerus*; posterior tooth of oncyli also strongly developed, but tooth t_1 very weak in specimens examined.

Ninth and tenth abdominal sterna (Fig. 15J)

Similar to *A. procerus*. Ninth sternite bearing transverse row of six setae; division between the two segments clearly indicated. *Raster*: tegilla separate as in *A. procerus*, each consisting of about twenty-five spine-like setae. Septum present and wider posteriorly, flanked on each side by about ten to twelve pali. Otherwise as in latter species. Anal lips similar to those of *A. moestus*, but both of the same size in most specimens seen.

Pupa (Fig. 15O)

Yellowish white and very similar to that of *A. procerus*, but smaller. Length 6,2–7,0 mm (posterior hooks excluded).

BIOLOGY

Aphodius laetus beetles were collected in fresh and semi-fresh cow-dung almost throughout the year. Larvae were observed during the winter and spring and were found together with those of *A. consimilis*. They were fairly heavily parasitized by the dextiid, *Pretoriamyia sellifera* van Emden. When mature, the larvae construct soft clay cells either in the soil or in the dung in which the prepupae and pupae are formed.

The pupal stages lasted about 21 days in the laboratory during the winter and 12–14 days during the summer; adult beetles emerged during midwinter and early summer.

Aphodius moestus Fabricius

DESCRIPTION

Adult (Fig. 15E)

Previously described by Peringuey (1901). Straw-coloured and fairly shiny, particularly on pronotum; head and pronotum dark brown to almost black. Each elytron with two narrow, longitudinal, blackish marks. On each side of pronotum also brownish to blackish patch. Striae on elytra well indicated but not deeply punctate. Length 5,8–7,5 mm.

Widely distributed in Subsaharan region, also present in Sri Lanka, Madagascar and Malaysia (Schmidt 1910).

Larva (Fig. 15A)

Bluish white, with head dull, dark brown. Length 10,5–12,5 mm. Rather similar to *Aphodius laetus* and *A. procerus*. Abdominal segments 1–5 each divided into three annulets; segments 6–8 apparently with two annulets each. Sparsely covered with setae all over the body, with most setae on abdominal segments 1–5 small and spine-like. Each abdominal sternum with transverse row of four to six setae on middle. All legs more or less of same size, well developed and sparsely covered with setae, particularly coxae; claws (Fig. 15H) simple and acute, lacking two spine-like setae present in *A. laetus*; ventral surfaces of claws serrate and studded with minute denticles. Both femur and tibia with minute denticles on ventral side (absent in *A. laetus*).

Head (Fig. 15C)

Frontal sutures rather indistinct in old specimens, epicranial stem (coronal suture) as in *A. laetus*. Frons somewhat lighter in colour than epicranium in some specimens, in others just as dark and bearing only three long setae on each side. Two short paramedian setae or spines also present below frontoclypeal suture, forming part of anterior frontal setae. Epicranium with anterior corners darker in most specimens seen, dorsally with four setae as in *A. laetus*, as well as some minute setae on lateral margins, which are, however, not as conspicuous as in latter species. Antennae slightly shorter than cranium, with four large and small fifth segments; separation of the first two segments very indistinct.

Labrum and clypeus

Setal pattern of labrum as in *A. laetus*, except two posterior setae immediately in front of clypeal border absent. Clypeus about as long as labrum; very convex in lateral view and with one long seta on each side, as well as two smaller paramedian setae.

Epipharynx (Fig. 15G) as in *A. laetus*, except crepis is much better indicated and distal section of hairs flanking anterior part of epitorma larger, covering almost whole of protophoba. Two or three strong setae in central part of dextrophoba are characteristic of both this species and *A. laetus*; they are not as obvious in *A. procerus*.

Mandibles (Fig. 15Q)

Stridulatory areas absent in both mandibles. Lateral side of each mandible rounded dorsoventrally, without distinct dorsal carina and with imperfect scrobis. Only two small setae observed on each mandible of which proximal one is situated on lateral face. Cutting edges very similar to those of *A. laetus*; apical tooth much longer on both mandibles. On left mandible scissorial notch much more distinct and second tooth (t_1) fairly obvious in most specimens, giving cutting edge a tridentate appearance. In both mandibles the neck much longer than in *A. laetus*. Molar areas of both mandibles similar to those of the latter; dorsomolar setae, however, arranged in form of transverse row on left mandible.

Maxillae (Fig. 15R)

Similar to that of *A. laetus*. Galea and lacinia free apically, latter with seven strong setae on dorsal side and apically with three unci. Ventrally with two setae only, apical one spine-like as in *A. laetus*. Galea bears single uncus, with two adjacent curved setae as well as longitudinal row of closely adjoining setae ventrally; dorsally with about seven strong setae of which two are situated on lateral side of uncus. Stipes with two setae dorsally and a row of eight to nine stridulatory teeth; also about three stridulatory teeth near base of palpifer; ventrally with only single proximal and single distal seta, as in *A. laetus*. Palpifer and basal palpal segment with single ventral seta; penultimate segment with one ventral and one lateral seta. Labacoria with three ventral setae.

Labium

Similar to that of *A. laetus*, but with only two long setae on postmentum.

Hypopharynx (Fig. 15S) also very similar to that of *A. laetus*, except that hypopharyngeal sclerite is somewhat better sclerotized. Glossa with same number of setae as in latter species.

Ninth and tenth abdominal sterna (Fig. 15B)

Distinct line of demarcation between ninth and tenth sternum present as in *A. procerus*. Raster very different from that of either *A. procerus* or *A. laetus*, as septum is absent. Two tegilla more or less fused, and with about seventy small black tubercles, each with small hamate seta (almost as in *Oniticellus*). Barbula absent. Anal opening visible as transverse slit (Fig. 15D), lower anal lip smaller than upper lip and divided ventrally by acute emargination; lateral margin on each side slightly emarginate in most specimens seen; very similar to *A. laetus* and *A. procerus*, but ventral incision much deeper.

Pupa

Similar to that of *A. procerus* (Fig. 16L), including caudal hooks. Length 6,5–7,4 mm (excluding caudal hooks). Colour pale whitish brown, but turning to dark colour a few days before beetle emerges.

BIOLOGY

Eggs of *Aphodius moestus* (Fig. 15F) were found in fresh cow-dung near Montagu during the summer months. They are whitish, oval and matt, 1,5 mm long and 1,0 mm broad. All the eggs collected during the summer had an incubation period of at least 5–6 days, the young grubs being about 2,5 mm long just after hatching. At first they are almost pure white, but soon the head becomes darker, almost golden brown. The setal pattern of the first instar is almost the same as that of the mature larva, except that the very small paramedian setae on the clypeus and the median pair of anterior frontal setae are absent. In all specimens seen, the posterior pair of dorso-epicranial setae (des_2) is also absent.

Large numbers of full-grown larvae and pupae were found in fresh dung during the autumn and beetles were observed almost throughout the year. The life-cycle from egg to adult during December and January occupied 30–33 days. All the pupae collected were found in small clay cells in the partly dry dung which remained after the feeding of the various coprophagous insects.

The newly-emerged beetle is pale brownish yellow, almost straw coloured on the elytra as well as on the pronotum, with the central part of the latter brownish; the head is brown and the legs yellowish. After a day or two it assumes its normal colour.

Aphodius procerus Harold

DESCRIPTION

Adult (Fig. 16A)

Previously described by Peringuey (1901). Brownish in colour, with prothorax darker in middle and usually finely pitted. Elytra striate, the striae with one row of punctures each. Head also finely punctate. Prothorax about as wide as elytra and whole insect moderately shiny. Length 11–12,5 mm.

Widely distributed in the western Cape (Peringuey 1901).

Larva (Fig. 16H)

Mature larva measures 16–17 mm in length. Colour bluish white, with head dark blackish brown to almost black, and matt. Abdominal segments 1–6 with three annulets; setae on segments 2–6 short and almost spine-like. Legs sparsely covered with setae. Claws (Fig. 16G) simple and acute, each bearing two small setae near base. Each abdominal sternite, except segment 10, with transverse row of six to eight long setae.

Head (Fig. 16I)

Frontal sutures distinct. Areas around antennal bases whitish, anteclypeus and labrum yellowish to brownish yellow. Frontoclypeal suture distinct. Frons with only two long setae on each side and also two short paramedian anterior frontals. Epicranium with four setae on dorsal side as in *Aphodius laetus* and

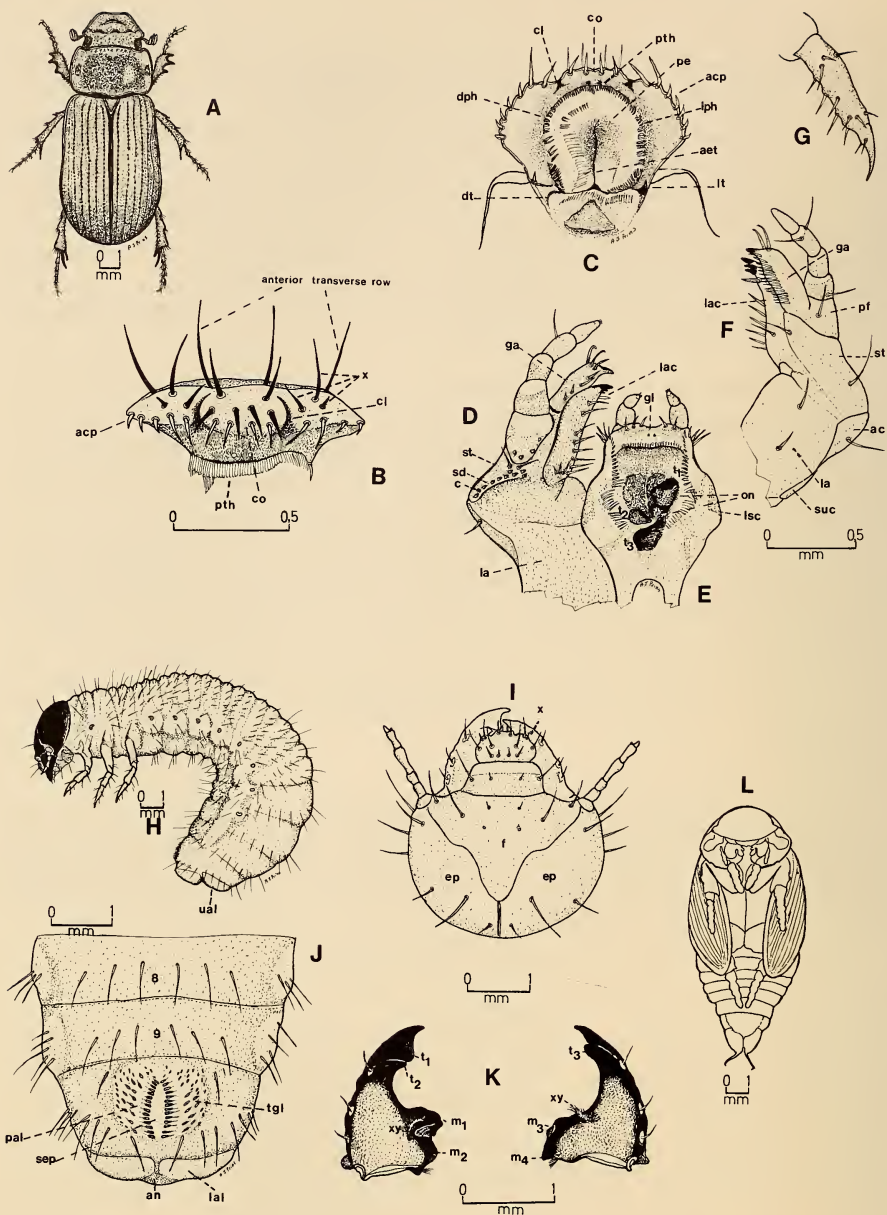


Fig. 16. Scarabaeidae. *Aphodius procerus*. A. Adult. B–K. Larva. B. Anterior margin of labrum, viewed directly from the front. C. Epipharynx. D. Left maxilla, dorsal view. E. Hypopharynx. F. Left maxilla, ventral view. G. Right mesothoracic leg. H. Larva, left lateral view. I. Head, dorsal view. J. Apical abdominal segments, ventral view. K. Mandibles, dorsal view. L. Pupa, ventral view.

A. moestus. Antennae slightly more than half the length of cranium, with five movable segments of which apical one is very small and bears two oval sensory grooves.

Labrum and clypeus

Labrum divided by clithra; median lobe bearing four strong setae dorsally on extreme anterior margin and two long setae further posteriorly (Fig. 16B). One long and two short setae (x) present laterad of each clithrum on lateral lobes (Fig. 16B, I); posterior to these are two transverse rows of four setae each; in some specimens posterior row contains only two to three setae. Clypeus of about same length as labrum and bearing transverse row of four setae on postclypeus.

Epipharynx (Fig. 16B–C). Distinct clithrum present on each side of corypha; latter with four medium long spine-like setae. Pedium large, raised and encircled by setae of proto-, dextro- and laeophobae. Tormae (dt and lt) narrow and merely indicated by suture; anterior epitorma elongate and ending in central cavity. Each torma with short spine on lateral margin, which apparently forms part of acanthoparia. Central area of pedium concave; anterior epitorma flanked on right by fine hairs. Each acanthoparia with five short stout spines and distally with two longer spine-like setae. Chaetoparia and acroparia absent. Boundary line of epipharynx and pharynx not clearly indicated by crepis in specimens examined; area enclosed by latter (also known as haptolachus, which is actually situated on clypeus) only with triangular sclerotized plate, in front of which is transverse row of fine hairs.

Mandibles (Fig. 16K)

Nearly as long as the cranium; dorsal carinae rounded and not clearly indicated; scrobis imperfect and bearing three short, sickle-shaped setae. Cutting edge of left mandible blade-like; scissorial notch distinct on both mandibles. Posterior scissorial tooth (t_3) on the right mandible rounded in most of specimens examined. Molar area of left mandible divided into distal and proximal lobe; distal lobe (m_1) with broad transverse cutting edge, with curved row of dorso-molar setae (xy); proximal lobe (m_2) broad, its dorsal aspect sharp. Molar area of right mandible entire, with transverse groove in front of small ventral tooth (m_3) and bearing fine setae (xy); proximal tooth (m_4) pointed posteriorly. Fine setae on posterior part of molar area of both mandibles present as brustia.

Maxillae (Fig. 16D, F)

Galea and lacinia fused, but delimited dorsally and ventrally by deep suture; apices free. Galea bearing single strong apical uncus and two to three strong curved setae; dorsally with longitudinal row of about five strong setae and ventrally with another row of closely approximated slender setae. Lacinia with three well-developed apical unci. Mala dorsally with row of nine to eleven strong setae, and ventrally with only one strong seta near unci; also with another seta close to its base. Stipes dorsally with two setae close to base of palpifer as well as well-defined carina (c) with row of about nine stridulatory teeth. Base of palpifer

also with four stridulatory teeth; ventrally with single seta. Labacoria bare on dorsal side but ventrally with two long setae. Alacardo on both sides with single seta. Maxillary palp with four movable segments; ventral side of basal segment with single seta and also one on both external and ventral sides of penultimate segment.

Labium

Mentum trapezoidal, with strong seta on each side near base. Proximal sclerite of prementum wider than distal sclerite, fairly convex transversely in lateral view and with two paramedian setae. Distal sclerite with two setae close together near anterior margin; sclerite consisting almost of two parts due to presence of shallow longitudinal depression; each part with long median seta.

Hypopharynx (Fig. 16E). Distal region of glossa with three setae on each side. Transverse ridge in front of oncyli bears row of fine setae. Hypopharyngeal sclerite concave in middle; oncyli consisting of at least three strongly sclerotized teeth (t_1 , t_2 , t_3). Lateral sclerites not strongly developed. Oblique row of fine setae present on each side, laterad of oncyli, each row continuing anteriorly over lateral area of glossa, terminating on ventrolateral side of distal sclerite of prementum in three strong setae.

Ninth and tenth abdominal sterna (Fig. 16J)

Dividing line between these segments distinct. Lower anal lip (lamina sub-analis) divided into two sections in middle; upper anal lip (lamina supra analis) entire; both lips demarcated by thin, well-defined suture. Anus present as transverse slit. Barbula absent. *Raster*: tegilla separate; each tegillum with eleven to thirteen strong setae similar to pali, as well as some smaller spine-like setae. Septum long, wider in the middle; each pallidium with fourteen strong pali. Campus small, bearing only one long seta on either side of tegilla. Oblique row of long setae also present in front of anal lips.

Pupa (Fig. 16L)

Light or pale brownish, 11–12 mm long. Bare, almost without setae. Abdomen dorsomedially with carina as in *A. laetus*. Wing-covers longitudinally striate. Extreme apex of abdomen carrying two long hooks, which are curved inwards at tips. Few days before beetle emerges, pupa turns dark brown to piceous.

BIOLOGY

Aphodius procerus beetles were mainly observed during the winter and spring. The larvae feed on semi-fresh to semi-dry cow-dung and were collected from late autumn to early spring; they are easily recognized by the dull, dark-brown to almost black heads, which are white after each moult. Before the prepupal stage is reached the larva constructs an earthen cell either in the dung or in the upper few centimetres of soil, in which the prepupal and later, after a few

days, the pupal stage is formed. Pupae were found during the winter and early spring. Pupal stages lasted from 17–23 days and beetles emerged from August to October.

Aphodius consimilis Boheman

DESCRIPTION

Adult

Previously described by Peringuey (1901). Rather similar to, but somewhat shinier than *Aphodius moestus* and without longitudinal black stripes on elytra; punctato-striations less distinct. Smaller than latter, only 4.2–5 mm long.

Widely distributed in the Cape Province, also present in Mozambique (Schmidt 1910).

Larva

Very similar to *A. moestus*. First six abdominal segments each with three annulets, seventh and eighth apparently with only two. Setal pattern similar to *A. laetus*, but lacking denticles present in *A. moestus*. Smaller than those of above two species, measuring only 7–8 mm when mature. Body bluish white; head shiny golden brown. Each abdominal sternum with about eight (or slightly more) setae.

Head (Fig. 17C)

About 1.25 times wider than long. Coronal suture as in *A. laetus* and *A. moestus*. Frons with transverse row of four setae near frontoclypeal suture, which is well defined; also with long seta on each side, laterad of antennal base. Epicranium with longitudinal row of three dorso-epicranial setae as well as one exterior dorso-epicranial seta on each side; anteriorly with single long seta near antennal base. Antennae slightly more than half the length of cranium, appearing four-segmented; the first and second segments almost immovably united; apical segment small, bearing at least one large sensory spot and some sensory pegs; penultimate segment also with sensory grooves on protuberance as in other species.

Labrum and clypeus

Two well-defined clithra present, dividing labrum into small median and two lateral lobes. Setal pattern of labrum as in *A. laetus*; also with two smaller setae near clypeal border. Clypeus slightly longer than the labrum, with same setal pattern as in latter species.

Epipharynx (Fig. 17E) very similar to that of *A. laetus* with same setal pattern; also with one or two strong setae in middle of dexiophoba. Tormae fairly symmetrically developed and crepis fairly distinct.

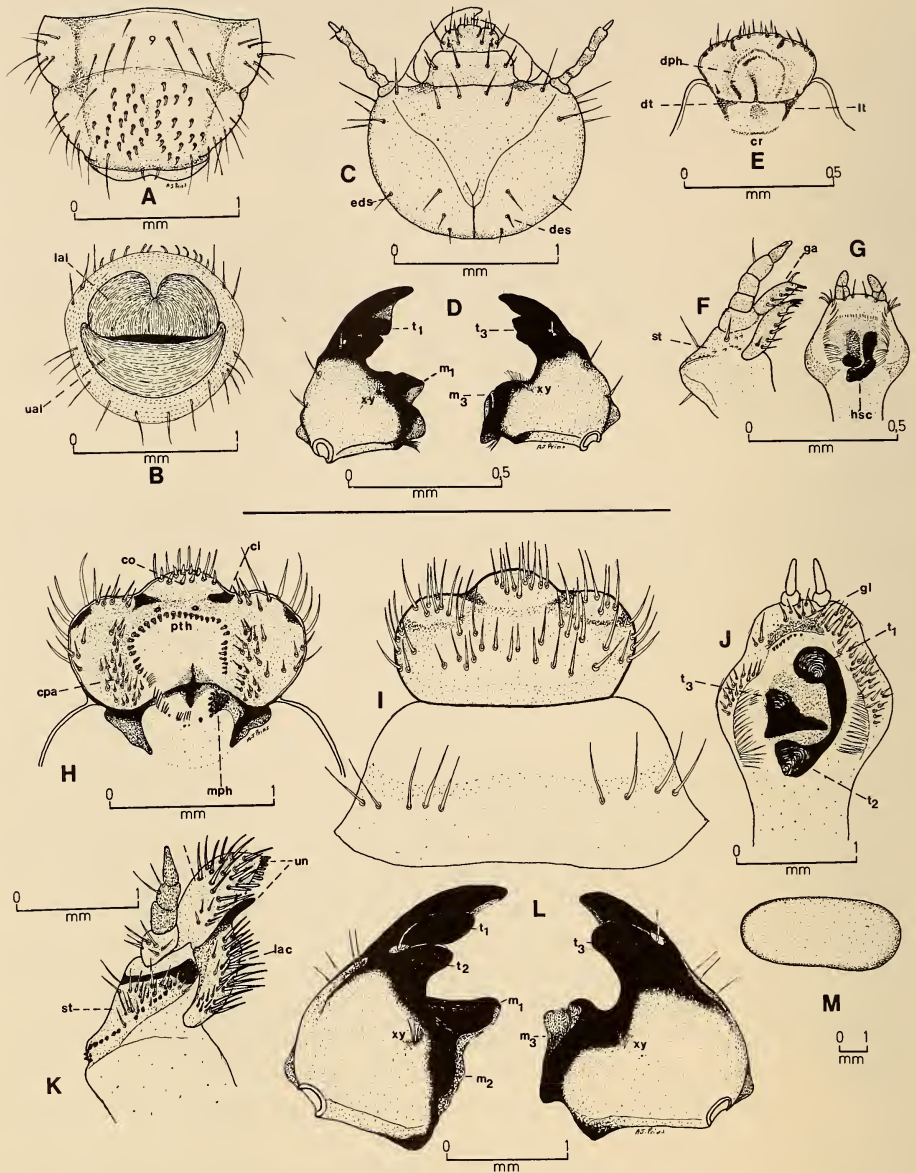


Fig. 17. Scarabaeidae. A-G. *Aphodius consimilis* larva. A. Apical abdominal segment, ventral view. B. Anal opening, viewed directly from the rear. C. Head, dorsal view. D. Mandibles, dorsal view. E. Epipharynx. F. Left maxilla, dorsal view. G. Hypopharynx. H-M. *Onitis aygulus*. H-L. Larva. H. Epipharynx. I. Labrum and clypeus, dorsal view. J. Hypopharynx. K. Left maxilla, dorsal view. L. Mandibles, dorsal view. M. Egg.

Mandibles (Fig. 17D)

About 1,2 times wider than long. Rather similar to those of *A. laetus* (Fig. 15P), with neck very short and the lateral sides rounded. Dorsal carina rounded and scrobis indistinct. Three setae visible on dorsal side, of which one is situated on lateral face. Cutting edge of left mandible broad, scissorial notch clearly indicated. Second tooth (t_1) fairly blunt or rounded. Cutting edge of right mandible similar to that of *A. procerus*, but second tooth (t_3) broad and in some specimens almost bilobed. Molar areas similar to those of *A. laetus* and *A. procerus* (including dorsomolar setae). Both mandibles with brustia.

Maxillae (Fig. 17F)

Galea and lacinia free apically as in other *Aphodius* species; galea with a single uncus and dorsally with five setae. Ventrally galea bears longitudinal row of closely approximated setae as in *A. procerus* as well as a single seta on lateral margin near apex. Lacinia with three well-developed unci, of which distal one is largest, and single ventral seta, situated close to proximal uncus. Dorsally there are six strong setae near mesal margin. Stipes dorsally with row of about eight stridulatory teeth of which at least five are fairly conspicuous; two or more stridulatory teeth and single seta located near base of palpifer. In the other *Aphodius* species described here there are two setae in this position. Ventrally there are two setae as in *A. laetus*; four-segmented maxillary palp, including its setae, as in *A. laetus*. Labacoria dorsally bare, ventrally with two setae. Alacardo with a single seta.

Labium

Similar to that of *A. laetus* and *A. moestus*, but the postmentum with only one seta on each side.

Hypopharynx (Fig. 17G) similar to the other three species described above. Hypopharyngeal sclerite well developed, oncyli almost as in *A. procerus*. Lateral sclerites fairly well developed; transverse row of setae in front of the hypopharyngeal sclerite indistinct.

Ninth and tenth abdominal sterna (Fig. 17A)

Rather similar to those of *A. moestus*, the two segments clearly demarcated. *Raster* consisting of two tegilla, which are fused proximally but separated distally in some specimens. Each tegillum with twenty-three to twenty-five hamate setae; in old specimens each seta situated on tiny black tubercle as in *A. moestus*. Barbula absent. Anal lips (Fig. 17B) similar to *A. moestus*, but lower anal lip much larger and in most specimens slightly larger than upper anal lip.

Pupa

Similar to that of the other *Aphodius* species described here (including abdominal hooks), but smaller. Length 4,2–4,9 mm. Yellowish white in colour but becoming dark brown just before emergence of imago.

BIOLOGY

Aphodius consimilis is one of the most numerous scarabs found in fresh to semi-dry cow-dung in the southern and western Cape. It is usually associated with other species, such as *A. moestus*, *A. discoidalis*, *A. procerus*, etc. Larvae of this species were collected almost throughout the year, except in midwinter. The eggs resemble those of *A. moestus* and measure from 0,56 by 0,44 mm to 1,0 by 0,64 mm. They are slightly shiny, dirty white and almost transparent and, as in all other scarab eggs, they increase in size after oviposition. All eggs were laid in semi-fresh to semi-dry cow-pats, in groups of five or more, and were never found in fresh dung. When mature, the larva constructs a little clay cell in which the whitish prepupa and later the pupa is formed. If dung is still available, the cells are constructed in the remains of the pats, otherwise in the top layer of the soil. According to observations made the incubation period of the eggs seems to be the same as for *A. moestus*. The larval period occupied 19–25 days during August to September and the pupal stage 16–18 days. The whole life-cycle was completed in 35–47 days in specimens kept in the laboratory (16–22 °C). Newly-emerged beetles are straw coloured.

Onitis aygulus (Fabricius)

DESCRIPTION

Adult

Described by Peringuey (1901) and Skaife (1953). Thorax bronzy green, elytra more greenish brown. Similar to *Onitis caffer* in general form and shape. Elytra with seven distinct striae. Length varying from 18,3 to 23 mm.

Widely distributed in the western and north-western Cape; also present in South West Africa (Ferreira 1978).

Larva

Larva rather similar to that of *O. caffer*, as described by Oberholzer (1958). As only few mature specimens were available for study, it was difficult to determine exact number of annulets, but abdominal segments 1–6 appear to have three annulets and segments 7 and 8 only two. All annulets, except probably first two, with scattered setae and those on at least first three segments arranged in single transverse rows; spine-like setae occur on segments 3–10. Spiracles and legs as in *O. caffer*. Sterna almost devoid of setae, except tenth sternum.

Head

Similar to that of *O. caffer*. Fairly smooth and colour golden, yellow brown, marbled with iridescent pale blue on certain areas in some specimens. Ocelli absent. Antennae four-segmented; apical segment small and bearing sensory cones. As very few specimens were available, a reconstruction of the mouth-parts

was made from cast skins and compared with those that could be preserved for drawing.

Labrum and clypeus (Fig. 17I)

Differ from those of other scarab larvae described here by presence of large numbers of setae, particularly on labrum. Two clithra divide latter into three rounded lobes, each bearing large number of setae, which are also continuous on median area. Postclypeus bearing median transverse row of nine to ten long setae. Both the clypeus and labrum seem to agree well with those of *O. caffer*, but judging by the figures of Oberholzer (1958), labrum more setose in latter.

Epipharynx (Fig. 17H) rather similar to that of *O. caffer*, but acanthopariae seem to be represented by only two or three setae on each side. Each chaetoparia with at least twenty-two to twenty-six setae; acroparia with about six setae each; corypha with about twelve strong rounded spines. Posterior epitorma better developed than anterior one and two sensilla present anterior to protophoba. Mesophoba sclerotized on left side and forms part of laeotorma; lateral lobes each with small strongly sclerotized area. Fused tormae, and anterior and posterior epitormae fairly well developed. Otherwise as in *O. caffer*.

Mandibles (Fig. 17L)

Reddish brown, cutting and molar areas black. Only slightly longer than wide and nearly as long as cranium. Dorsal carinae rounded, scrobis indicated by short shallow depression with about four setae; also single curved seta present in middle of neck between teeth t_1 and t_2 . Stridulatory areas absent on both mandibles. Judging by Oberholzer's figures, mandibles are fairly different from those of *O. caffer*. In *O. aygulus*, cutting edge of left mandible is clearly tridentate; scissorial notch fairly wide and distinct. On right mandible cutting edge is bidentate with wide and deep notch between first and second tooth (t_3). Molar area of left mandible clearly divided into proximal (m_2) and distal (m_1) lobe; latter long and broad. On right mandible division not so clear, molar area forming a wide tooth (m_3) ventrally. Short oblique row of fine dorsomolar setae (xy) present on each mandible.

Maxillae (Fig. 17K)

Rather similar to those of *O. caffer*. Galea and lacinia free, latter with single strong uncus, its mesal margin beset with strong setae. Ventral side of lacinia with numerous setae. Galea with very small uncus surrounded by curved row of about eight rounded spines, which continue as strong setae on ventral side. Whole of ventral area studded with hamate setae, its dorsal surface with numerous strong setae. Palpifer of three-segmented maxillary palp with about fourteen setae. Stipes with one long and some short ventral setae; dorsally with about eighteen setae and sixteen conical stridulatory teeth. Penultimate segment of maxillary palp with two setae on lateral margin.

Labium

Similar to that of *O. caffer*, palpi with apical segment fairly long.

Hypopharynx (Fig. 17J). Glossa with about ten hairs in middle and numerous setae on right side. Left side with only two setae in specimens examined. Right lateral sclerite with numerous spine-like setae; left one with only twenty to twenty-two spine-like setae. Oncyli on right side with two well-developed teeth (t_1 and t_2); third tooth (t_3) more weakly developed.

Ninth and tenth abdominal sterna (Fig. 18C)

Rather similar to those of *O. caffer*. The two sterna clearly demarcated. The two palidia long, each with eighty-seven to ninety-two pali, anterior third separated from the rest. Tegilla as in *O. caffer*, each one with numerous palus-like setae. Septum long, somewhat wider posteriorly. Anal lips similar to those of the latter species.

BIOLOGY

Skaife (1953) describes the biology of *Onitis aygulus* and according to him the beetle first digs a tunnel in the soil beneath the dung. At the bottom of this tunnel a large chamber is excavated into which a mass of dung is carried and in this mass the eggs are deposited at intervals as the filling of the chamber proceeds. The cells in which the eggs are laid are always made near the surface of the dung.

About six white, oval eggs (Fig. 17M) are laid and these hatch within about 14 days. When fully grown each larva makes a cell in which pupation occurs. The pupal stage lasts 14–21 days.

In sandy areas along the west coast, the oblong whitish eggs of this species were often observed in semi-fresh cow-pats during January. Fairly large larvae (about 35 mm long) that hatched from such eggs were collected from hollowed-out chambers in the pats in the same areas during the end of January and beginning of February. Pupae from these larvae were about 16 mm long, pale lemon yellow, and remained in the cells for about 38 days during September before the beetles emerged. Under such conditions larval stages lasted for about 202 days before pupation occurred and the newly-emerged beetles were reddish brown on the thorax with yellowish elytra and reddish legs.

Oniticellus pictus (Hausmann)

DESCRIPTION

Adult (Fig. 18A)

Previously described by Peringuey (1901). Length 6.4–8.7 mm. Pale yellowish or flavous with large black triangle on head, large black patch on pronotum and some black spots on elytra. Pronotum broader than elytra with conspicuous pits which are usually obsolete on central part; also small black spot on each side of pronotum. Legs flavous, marked with black.

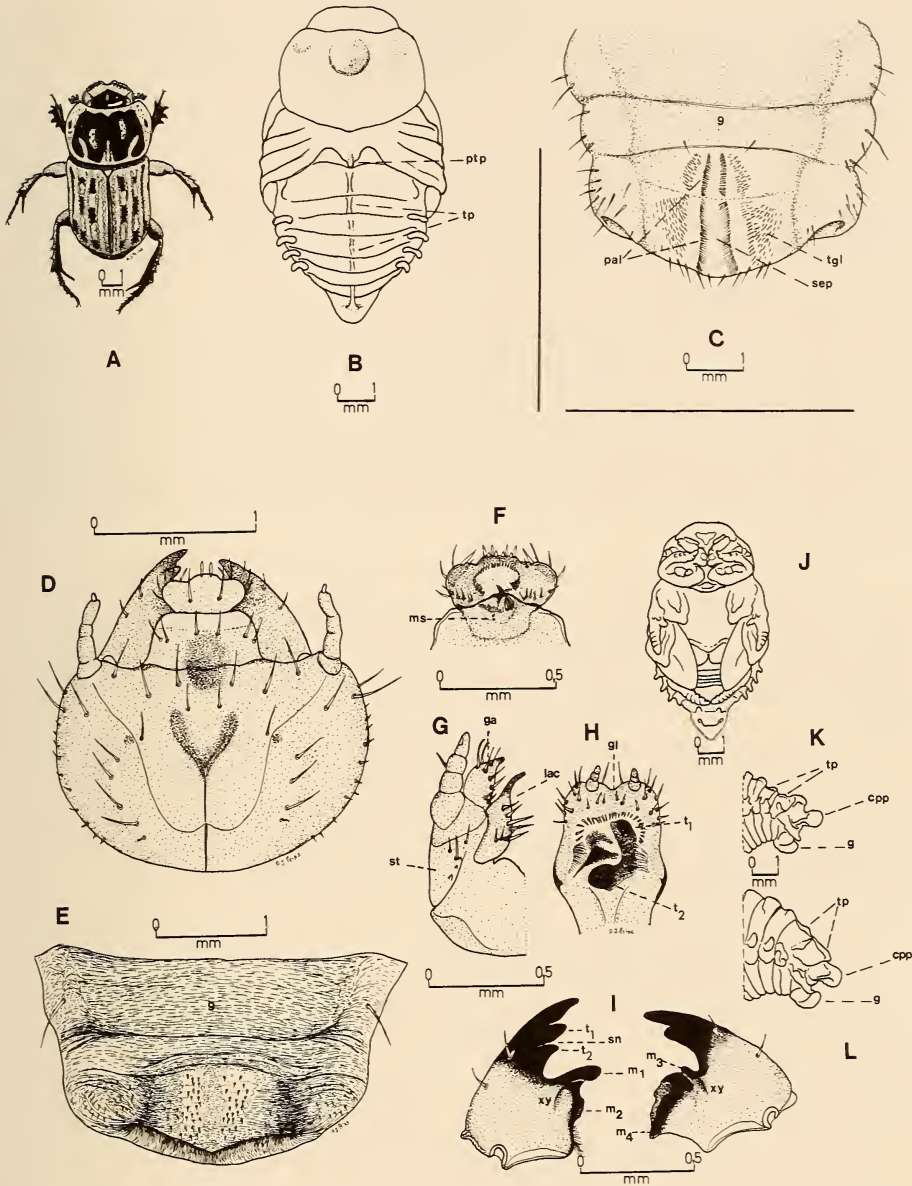


Fig. 18. Scarabaeidae. A. *Oniticellus pictus* adult. B. *Oniticellus pictus* pupa, dorsal view. C. *Onitis aygulus* larva, apical abdominal segments, ventral view. D-K. *Oniticellus pictus*. D-I. Larva. D. Head, dorsal view. E. Apical abdominal segments, ventral view. F. Epipharynx. G. Left maxilla, dorsal view. H. Hypopharynx. I. Mandibles, dorsal view. J. Pupa, ventral view. K. Apex of pupa, left lateral view. L. *Oniticellus planatus*, apex of pupa, left lateral view.

Attracted to fresh and semi-fresh cow-dung as in the case of *Oniticellus planatus*. Widely distributed in South Africa; also present in Zaïre and east Africa (Janssens 1953).

Larva

Very similar to that of *O. planatus* (Fig. 19C), but smaller. Abdominal segments 5–8 with two rows of dorsal setae; fourth segment dorsally with short spines only. Prothoracic shield angular on each side, but not toothed.

Head (Fig. 18D)

Only slightly wider than long, similar to that of *O. planatus* and having same depressions. Frons with transverse row of four setae near clypeofrontal suture and posterior to this two smaller paramedian setae; also single seta present on each side near middle of frontal suture. Single seta present just mesad of each antennal base. Epicranium anteriorly with three setae and posteriorly with longitudinal row of four to five setae as in *O. planatus*. Sides of epicranium with very small setae.

Labrum and clypeus

Labrum about twice as wide as long with the same number of setae as in *O. planatus*. Clypeus also twice as wide as long, about one-third longer than labrum and with two long paramedian setae and two lateral setae on each side.

Epipharynx (Fig. 18F) very similar to that of *O. planatus* but clithra not sclerotized. In mature larvae corypha and lateral lobes strongly sclerotized, as well as anterior and posterior epitormae. In all specimens examined each acroparia with one seta. Mesophoba in most specimens seen with long setae. At least one pair of macrosensilla clearly visible in most specimens.

Mandibles (Fig. 18I)

Slightly more than half the length of cranium. Dorsal carina rounded and scrobis indistinct and, as in *O. planatus*, with only two setae dorsally. Cutting edge of left mandible with three teeth, scissorial notch distinct. Molar area divided into two lobes; distal one (m_1) long, broad and emarginate in middle; proximal lobe (m_2) as in *O. planatus*, with a fringe of hairs posteriorly. Right mandible similar to that of *O. planatus*, but molar area with strong ridge (m_3) anterior to it. Each mandible also with longitudinal row with fine dorsomolar setae.

Maxillae (Fig. 18G)

Similar to that of *O. planatus*. Galea with single short uncus, dorsally with seven setae, ventrally beset with about twenty-five setae on mesal area. Lacinia with single long uncus and eight strong setae dorsally; ventrally with five to six setae of which the apical one is very short and spine-like in young specimens.

Labacoria ventrally with two small setae; dorsally bare. Alacardo with about three setae. Stipes ventrally with two setae and dorsally with three of which posterior one is longest. Three inconspicuous stridulatory teeth also present. Palpifer with two setae situated close together ventrally; penultimate segment of maxillary palp with single long seta on the ventral side and one on lateral margin.

Labium

Postmentum trapezoidal; in mature specimens anterior part with broad rounded ridge bearing only two short setae near base. Proximal sclerite of prementum convex, transversely divided by shallow notch into two halves, each with three setae, inner ones longest. Distal sclerite of prementum divided by depression into two globular lobes, each with ten to twelve setae.

Hypopharynx (Fig. 18H). Glossa deeply cleft by depression into two halves, each with five to seven setae; oncyli forming two strong teeth on right side, as in *O. planatus*; left one with transverse tooth. Oncyli anteriorly encircled by a row of strong setae in front of which there is transverse row of six setae. Each lateral sclerite with row of fine hairs laterad of oncyli.

Ninth and tenth abdominal sterna (Fig. 18E)

Ninth and tenth segments clearly demarcated. *Raster* similar to that of *O. planatus*, but iridescent areas oblong and narrow, beset on each side with twenty to thirty tiny black tubercles, each with tiny hamate seta. Tenth sternite in form of wide V-shaped lip just below lower anal lip (in *O. planatus* it is widely convex, not V-shaped); otherwise as in the latter species. Barbula absent. Lateral areas of tenth segment beset with small setae.

Pupa (Fig. 18B, J–K)

Almost pure white when formed, but turning darker as imago develops. Length about 10 mm and, as in *O. planatus*, prothorax with large convex median raised area and inconspicuous swelling on each pronotal shoulder. Abdomen with four lateral projections, as well as pteronotal, dorsal tergal, and caudal support projections (ptp, tp and cpp). Extreme apical part of dorsal projection, as well as caudal projection and developing genital capsule fairly rounded so that there appear to be three rounded knobs on abdominal apex (in *O. planatus* there are only two which are fairly rounded, extreme apical part of caudal support projection not rounded but carinate).

BIOLOGY

As in *Oniticellus planatus*, the full-grown larvae of *O. pictus* are found in oval clay cells somewhat smaller than those of the former species, i.e. 10–11 mm in diameter. Prepupae and pupae are almost pure white and were collected during March and April together with those of *O. planatus* in the same cow-pats. Beetles emerged during April. Both these species seem to play an important part in the destruction of the dung, as large numbers of pupal cells were collected per

cow-pat in certain areas around Mossel Bay and in the Brandwag area between Mossel Bay and Oudtshoorn.

Oniticellus planatus Castelnau

DESCRIPTION

Adult (Fig. 19A)

Previously described by Peringuey (1901). Shiny black, elytra longitudinally striate, each stria with one row of punctures. Prothorax somewhat wider than elytra. Length 9,9–10,9 mm. Attracted to fresh and semi-fresh cow-dung and very numerous in the Mossel Bay area during the surveys. Widely distributed in Africa (Peringuey 1901; Janssens 1953).

Larva (Fig. 19C)

White in colour. Only pro- and mesothoracic segments with dorsal setae; metathoracic segment almost devoid of setae. Abdominal segments 3–7 with scattered setae dorsally; segments 8–9 apparently with two rows of setae; second abdominal segment with one row of setae dorsally. Legs with some setae, mostly on ventral side, coxae almost devoid of hairs; claws absent (Fig. 19H), but there is short terminal seta surrounded by circle of six to eight hairs. Prothoracic shield with transverse ridge on each side which is somewhat pointed in middle, but lacking triangular projections as in *Onitis caffer* (Oberholzer 1958). Spiracles as in *O. caffer* and with fairly long seta posterior to each spiracle.

Head (Fig. 19E)

Only slightly wider than long, frontal suture forming an inverted M, with arms not very clearly indicated anteriorly. Coronal suture extended to middle of cranium where it joins V-shaped notch or depression. Depression on fronto-clypeal suture extending on to posterior half of postclypeus. Frons with three long setae on each side as illustrated, two of which are situated medially, one on either side of depression near clypeal border; another pit present exterior to each of these setae. Epicranium with seven to eight dorsal setae on each side of which four are situated in longitudinal row near the frontal suture on a narrow area that is lighter in colour than rest of the cranium.

Labrum and clypeus

Labrum slightly less than twice as wide as long and deeply emarginate on each side of corypha; lateral lobes rounded. Middle lobe with about seven to eight strong setae; lateral lobes with four strong setae, the posterior two sickle-shaped; there are also two paramedian setae. Clypeus only slightly longer than labrum, with two lateral setae on each side and two paramedian setae on postclypeus.

Epipharynx (Fig. 19J). Clithra well developed and corypha with four strong, rounded spines. Each chaetoparia with eight setae and each acroparia represented by two strong setae. Pedium raised above level of lateral lobes and encircled

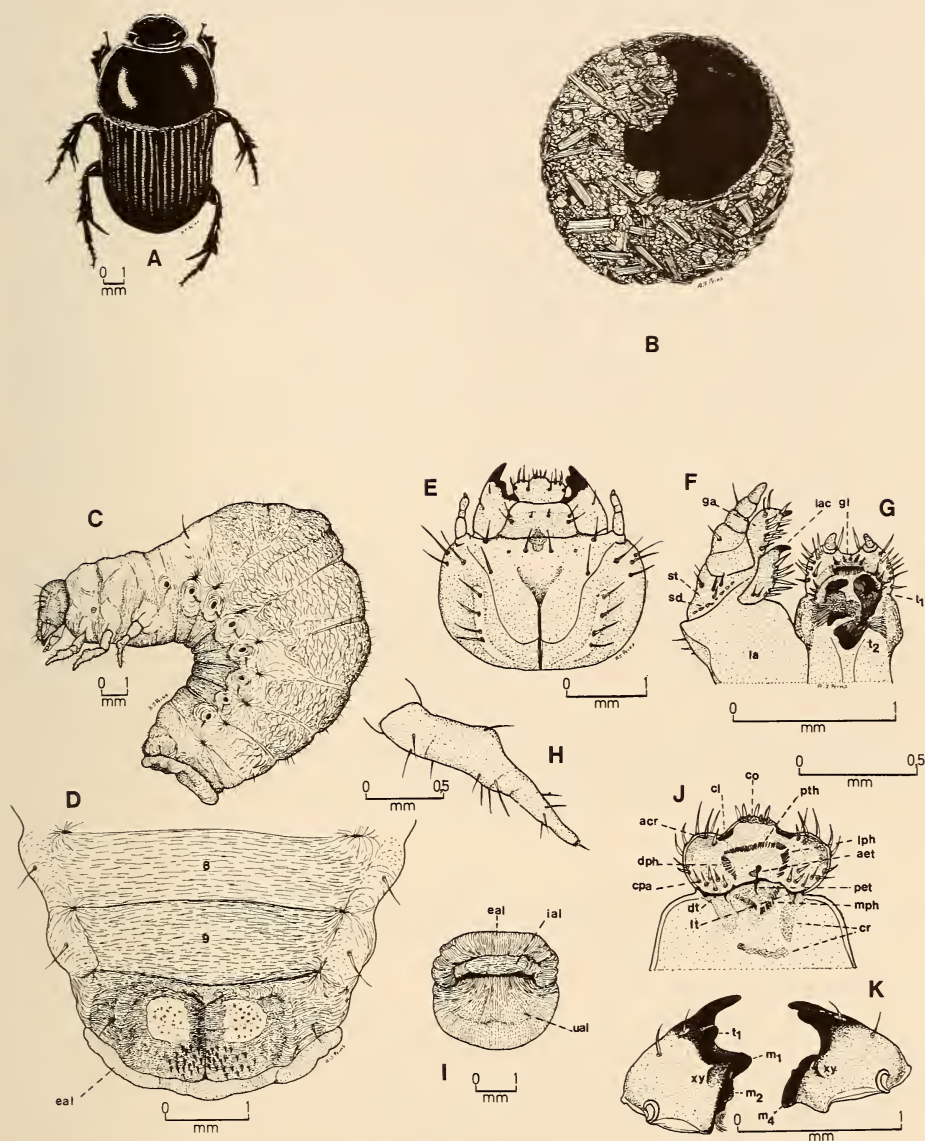


Fig. 19. Scarabaeidae. *Oniticellus planatus*. A. Adult. B. Clay cell. C-K. Larva. C. Left lateral view. D. Apical abdominal segments, ventral view. E. Head, dorsal view. F. Left maxilla, dorsal view. G. Hypopharynx. H. Right mesothoracic leg. I. Anal opening, viewed directly from the rear. J. Epipharynx. K. Mandibles, dorsal view.

by dextro-, laeo- and protophobae. Tormae (dt and lt) present as narrow sclerite; both anterior and posterior epitormae present. Crepis represented by three weakly sclerotized areas. Anterior half of area enclosed by crepis (haptolachus) raised; upper surface almost flat and surrounded by mesophoba.

Mandibles (Fig. 19K)

Slightly more than half the length of cranium; dorsal carina rounded; only two dorsal setae present and single ventral seta near molar area. Scrobis indistinct and stridulatory area absent. Distal cutting edge of left mandible narrow, scissorial notch in form of wide depression between apical tooth and molar area; also single small tooth (t_1) present below apical tooth. Molar area bilobed, distal tooth (m_1) broad and fairly sharp; proximal lobe (m_2) with arcuate posterior margin, bearing setae. Right mandible with two fairly rounded apical teeth, scissorial notch shallow. Molar area consisting of single broad oblique lobe that forms fairly strong tooth (m_4) pointing backwards; ventral tooth separated only at posterior end. Molar area on each mandible with small groove on dorsal side bearing fine dorsomolar setae.

Maxillae (Fig. 19F)

Galea and stipes free, each with single short uncus. Galea on dorsal side with about seven setae, and ventrally with twenty to thirty long setae on mesal side. Lacinia dorsally with about eight strong setae and ventrally with about five. Stipes dorsally with four setae as well as row of about eight small stridulatory teeth. Palpifer with two exterior setae and one long ventral seta. Penultimate segment of maxillary palp with single exterior and single ventral seta. Labacoria bare, except for two small ventral setae; alacardo with about four setae.

Labium

Distal sclerite of prementum divided by a depression into two almost conical halves, each bearing ten to twelve setae. Proximal sclerite of prementum convex and bearing median transverse row of six setae. Postmentum trapezoidal with two short setae near base.

Hypopharynx (Fig. 19G). Glossa widely emarginate apically, each half bearing about eight strong setae; hypopharyngeal sclerite strongly sclerotized, oncyli forming at least two strong conical teeth (t_1 and t_2). That part of glossa in front of oncyli strongly sclerotized, forming ridge bearing fine hairs. Anterior to this sclerotized area there is transverse row of about five short spine-like hairs. Longitudinal row of four spine-like setae present on each lateral side of oncyli.

Ninth and tenth abdominal sterna (Fig. 19D)

Ninth and tenth segments clearly divided, with inconspicuous, longitudinal ridge on tenth sternite, ending in front of lower anal lip in small V-shaped notch.

On either side of this ridge an almost oval iridescent bluish patch present and posterior to this a small tegillum bearing about twenty short, palus-like setae. Single long setae situated laterad of each iridescent patch, as well as some smaller scattered hairs. Anal opening transverse, surrounded by large upper anal lip (Fig. 19I) and smaller lower lip, divided into exterior and interior lobe. Barbula absent.

Pupa

Very similar to that of *O. pictus* and when newly formed almost pure white, but as imago develops it turns darker. Most of pupae collected range in length from 12 to 13 mm. Extreme apex of abdomen with two swellings, the dorsal one being the caudal support projection and the lower one the developing genital capsule (Fig. 18L). Longitudinal ridge or dorsal tergal support projection more or less carinate and obsolete on segments 4–7.

BIOLOGY

The creamy-white, almost pear-shaped eggs of *Oniticellus planatus* are laid singly in a small dung ball, 14.5–15 mm diameter, in which the larva feeds. When fully grown a clay cell (Fig. 19B) of similar size and shape is constructed from remains of the original ball, in which the prepupa and later the pupa is formed. When turning into prepupae the larvae become almost pure white, except for the mandibles, which are black. Pupal cells were collected during March and beetles emerged during April.

Newly-emerged beetles are light brown on elytra; the pronotum, head and legs pale chocolate brown and rather shiny. Up to fifteen pupal cells were collected from a single cow-pat, usually in association with *O. pictus*.

Pachnoda sinuata (Fabricius)

DESCRIPTION

Adult (Fig. 20C)

Yellowish beetle with dark-green coloration on pronotum and elytra. Ventral side of body yellow with red and white on sides and about six oval spots on maroon-coloured apex of abdomen; also two white spots on ventral side of abdominal apex. Head dark brownish with two long yellowish patches on each side of clypeus and two oval white spots above eyes. Length about 25 mm. A variable species of which several varieties have been described.

According to Peringuey (1907) *Pachnoda sinuata* is widely distributed in central, eastern and southern Africa. It seems to be fairly well represented in the western Cape Province, especially in the fruit-producing areas from Worcester to Somerset West, and has also been collected at Elands Bay. This contradicts Donaldson's (1979) statement that it does not occur in the south-western Cape.

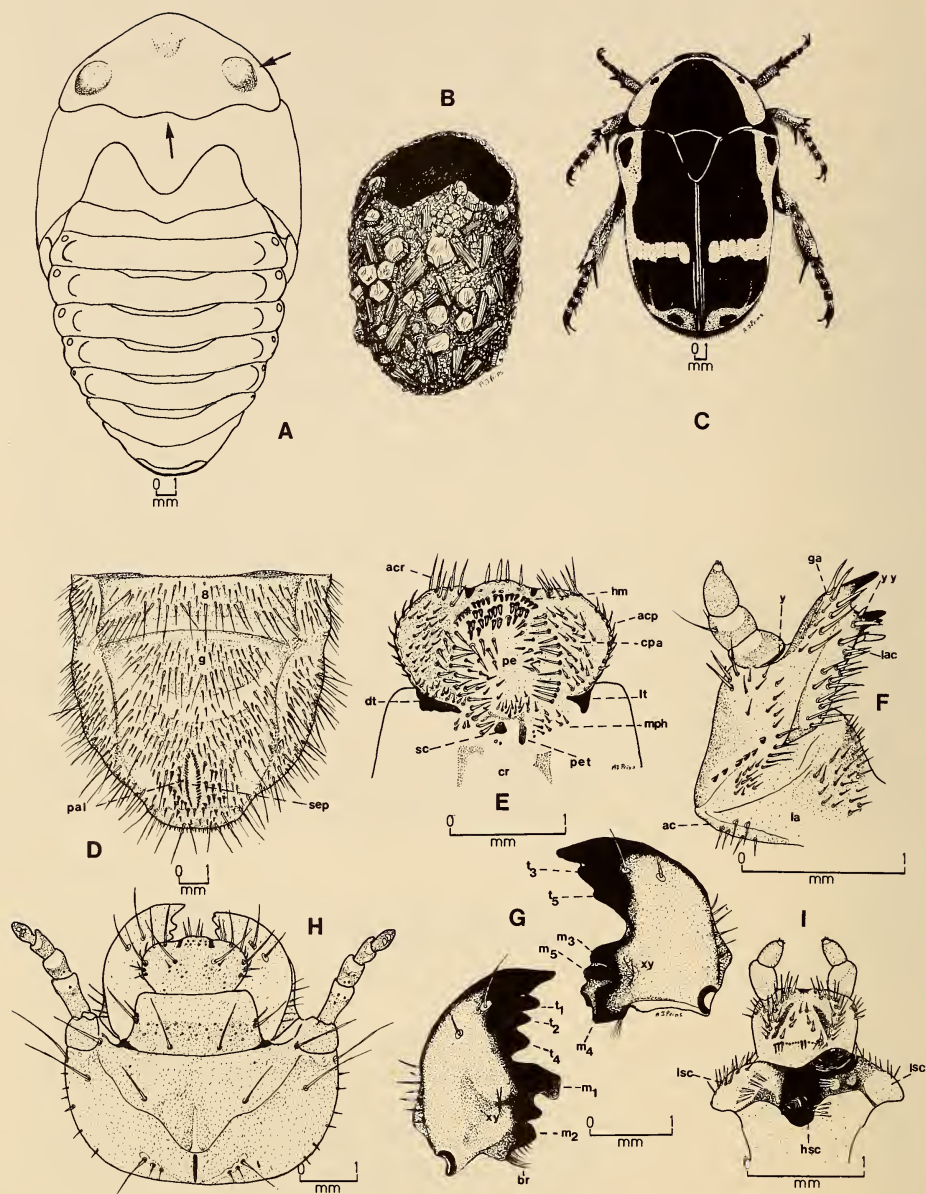


Fig. 20. Scarabaeidae. *Pachnoda sinuata*. A. Pupa, dorsal view. B. Clay cell. C. Adult. D-I. Larva. D. Apical abdominal segments, ventral view. E. Epipharynx. F. Left maxilla, dorsal view. G. Mandibles, dorsal view. H. Head, dorsal view. I. Hypopharynx.

It is fairly common around Milnerton, Pinelands, and even Beaufort West and Kuruman.

Larva

Very similar to that of *Rhinocoeta cornuta* (Fabricius) (Fig. 21D) in length, form and shape, but slightly more hairy on ventral side. Colour of hairs fulvous. Legs also similar to those of *R. cornuta*. As in the case of the latter species, they are able to stretch their bodies fully when walking.

Head (Fig. 20H)

About twice as wide as long, frontal sutures clearly indicated; anterior extension of coronal suture in most specimens visible as a paler, narrow area. Ocelli obsolete or faintly visible in some specimens as paler area just behind antennal bases. Cranium not marbled, or very weakly so; setal pattern almost same as that of *R. cornuta*. Antennae about as long as cranium, four-segmented; apical segment with five oval sensory spots as well as terminal spot with sensory pegs; penultimate segment also with sensory spot. First and second antennal segments each with three to four small pits. As in *R. cornuta*, antennae are bare, without any setae.

Labrum and clypeus

Labrum nearly twice wider than long; clearly divided into a median and two lateral lobes. Setal pattern almost the same as in *R. cornuta*, but with some short slender setae instead of short spine-like setae on its posterior half. Clypeus about twice as wide as long and also with same setal pattern as in latter species; postclypeus also pitted.

Epipharynx (Fig. 20E) very similar to that of *Pachnoda impressa* (Goldfuss) (Oberholzer 1959) and *R. cornuta*, and with about ten strong heli on hapto-merum; pedium with about twenty strong setae in anterior area, which are almost as strong as heli; two chaetopariae with fewer setae than in *R. cornuta*; each acroparia with about ten strong setae; crepis represented by two slightly sclerotized plates. Otherwise as in *R. cornuta*, except anterior epitorma not so clearly visible as in latter species and two pairs of macrosensilla transversely arranged in most specimens examined.

Mandibles (Fig. 20G)

Very slightly longer than cranium and about 1.25 times longer than wide. Rather similar to those of *R. cornuta*, but more robust, apical tooth shorter, particularly on right mandible. Dorsal carina rounded, scrobis obsolete and represented by two pits, as in latter species, each with seta, distal one longest; lateral face with about seven setae; brustia as in *R. cornuta*. Stridulatory area present ventrally on both mandibles. Cutting edges of both mandibles similar to those of latter species, but second tooth (t_1) on left mandible more acute. As in

R. cornuta, a depression present laterad of molar area on each mandible, bearing about eight fine dorsomolar setae. Otherwise exactly as in *R. cornuta*.

Maxillae (Fig. 20F)

Very similar to those of *R. cornuta*. Lacinia and galea fused, demarcating suture visible dorsally but totally absent on ventral side and separated by strong sclerotization, part of which is also visible on lateral margin. Galea as in *R. cornuta*; single uncus present. Dorsally with about six strong setae and about seven weaker ones exterior to these. On ventral side distally with eight or nine setae, proximally with only two to three.

Lacinia with two unci, dorsal one with strong spine (yy) at base, which is more obvious than in *R. cornuta*. Mesal margin of mala beset with numerous strong setae or spine-like setae, those bordering unci much more strongly developed. Stipes ventrally with single long setae near base and distally with about three setae on palpifer; latter not clearly demarcated. Dorsally with some fine setae (about twenty-eight or more) and row of six stridulatory teeth of which distal one is almost rounded, others acute. Otherwise as in *R. cornuta*. Maxillary palp with three distinct segments and basal or fourth segment represented only by narrow sclerotized plate (y). Penultimate segment with single ventral and lateral seta. Sensory spot not obvious on apical segment.

Labium

Very similar to that of *R. cornuta* and with the same setal pattern. Postmentum, however, more rectangular. Labial palps as in latter species, with sensory pegs at apex.

Hypopharynx (Fig. 20I) very similar to that of *R. cornuta*, and with almost similar setal pattern. However, lateral sclerites less sclerotized in most specimens seen and small tubercles or sensory pegs form transverse row in front of hypopharyngeal sclerite; in *R. cornuta* these are more scattered, forming somewhat curved row.

Ninth and tenth abdominal sterna (Fig. 20D)

The two segments fused with no demarcation line between them on ventral side. Raster as in *R. cornuta*, except that there are more palus-like setae on each tegillum and palidia are almost parallel, each one containing twenty-four to twenty-six pali. Septum thus formed is long and narrow and usually wider in middle. Anus and anal lips similar to *R. cornuta*.

Pupa (Fig. 20A)

Also similar to that of *R. cornuta*; yellowish brown, but becoming darker as imago develops. Length 23–25 mm. Apart from differences in developing genital capsule, pupa of *Pachnoda sinuata* is easily distinguished from that of *R. cornuta* by absence of prothoracic horn and by sinuate hind margin of pronotum (almost straight in *R. cornuta*). Each posterolateral angle of pronotum bears large

rounded tubercle or knob (absent in *R. cornuta*, and represented only by two oval folds).

BIOLOGY

In the western Cape Province larvae of *Pachnoda sinuata* are commonly found in compost heaps, particularly in the Milnerton, Pinelands and Somerset West areas. Large numbers of fairly small and fully mature larvae and pupae were found during the early winter (April, May) and beetles started to emerge from about midwinter. However, during the surveys large numbers of larvae remained in the soil in clay cells until the early spring when pupae were formed, the beetles emerging from September to November. These surveys indicated that beetles appear from late autumn to midwinter in the eastern and western Cape as well as in Natal; the peak period of emergence in the western Cape Province, however, occurred from early spring to late summer.

The larvae feed on organic material in compost heaps or other suitable accumulations of decaying organic matter and when fully mature they construct hard, oval clay cells, 25–30 mm long (Fig. 20B), in which the prepupal and later the pupal stages are formed. In some instances larvae collected remained for nearly a month in the prepupal stage before pupation occurred. Pupal stages lasted for 30–44 days in the laboratory at an average temperature of about 22 °C.

The newly-emerged beetle is pale yellow, marbled with dark green, the head and pronotum reddish; the ventral side is also pale yellow and reddish. However, after a few hours to about a day they assume their normal coloration, which is somewhat darker.

The rearing of *Pachnoda sinuata* larvae in the laboratory is described by Donaldson (1979).

Rhinocoeta cornuta (Fabricius)

DESCRIPTION

Adult (Fig. 21A)

Black, pitted all over (particularly pronotum) with setigerous punctures; areas between punctures shiny, except for the longitudinal matt strips on elytra. A tubercle or triangular tooth present medially on anterior margin of pronotum and behind this tubercle usually a wide depression. Legs, ventral side of thorax and head covered with long golden or fulvous hairs. Length 17–20 mm. For further details see Peringuey (1907).

Widely distributed in southern Africa (Schein 1960); abundantly found along the south coast of the Cape Province during present surveys.

Larva (Fig. 21D)

Mature larvae measure about 45 mm in length. Colour is whitish pink to pale pink, with reddish-brown to light-reddish head. Legs yellow; prothoracic shield yellowish brown; latter not angled or toothed in front. All spiracles cribriform,

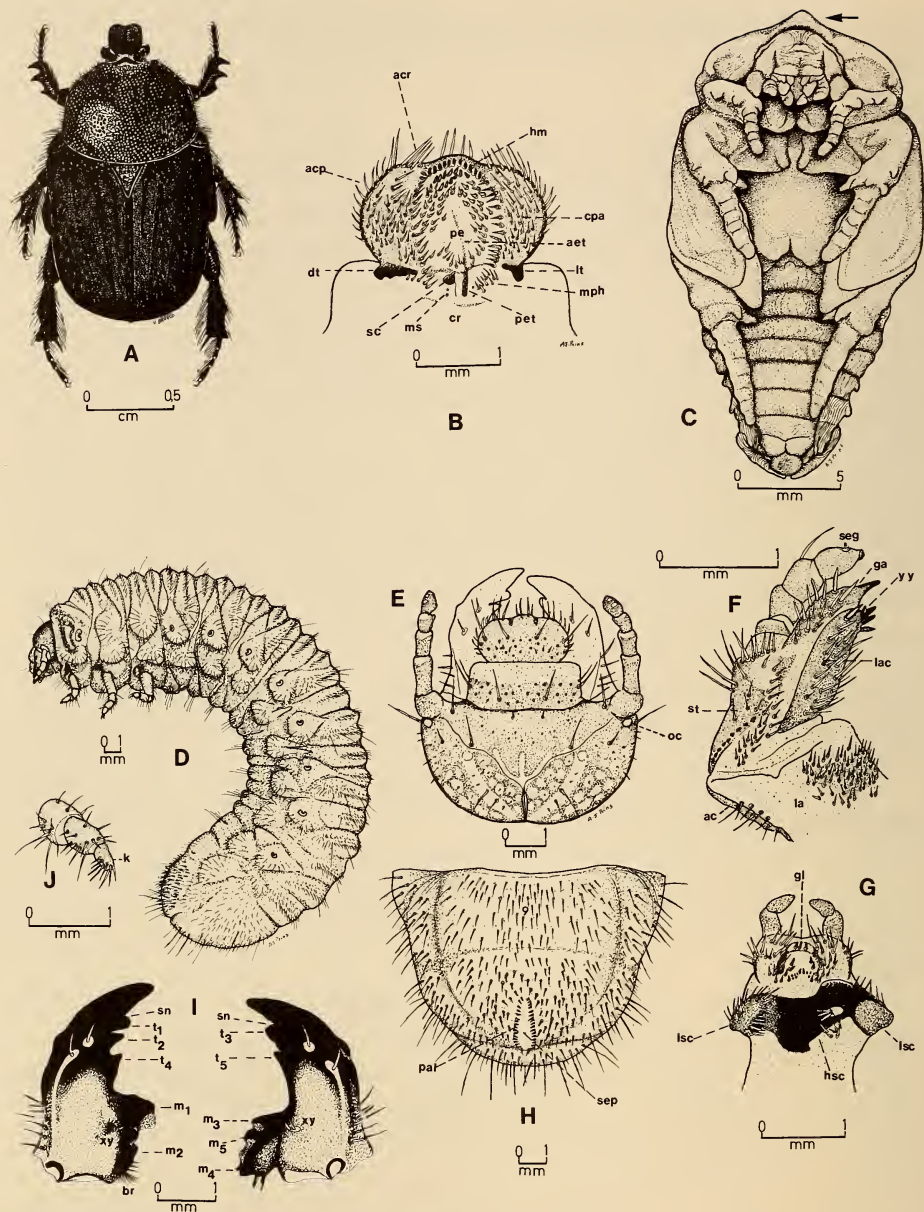


Fig. 21. Scarabaeidae. *Rhinocoeta cornuta*. A. Adult. B. Epipharynx of larva. C. Pupa, ventral view. D-J. Larva. D. Left lateral view. E. Head, dorsal view. F. Left maxilla, dorsal view. G. Hypopharynx. H. Apical abdominal segments, ventral view. I. Mandibles, dorsal view. J. Right mesothoracic leg.

with concavities pointing as illustrated; thoracic one largest. First seven abdominal segments with three annulets, eighth with two. Each annulet with broad band of long spine-like setae. Ninth and tenth terga almost completely covered with spine-like setae; also some long hairs present. Sterna of abdominal segments 1–8 with row of long hairs and also some shorter spine-like setae; colour of body hairs fulvous. Legs well developed and more or less of same size; claw of tarsungulus (Fig. 21J) rounded, fleshy, distally obtuse and surrounded by about ten strong setae.

The larvae are able to stretch their bodies fully when walking and when disturbed they usually turn on their backs and slide away from danger.

Head (Fig. 21E)

Slightly wider than long; brownish, smooth; epicranium almost marbled. Frontal sutures fairly distinct; coronal suture extended anteriorly as paler area, which sometimes has short branches lying next to frontal sutures. Ocelli present and clearly visible. Frons with one long seta on each side in most specimens seen, and two short spine-like paramedian setae just behind frontoclypeal suture, which is well demarcated; in older specimens with some tiny scattered pits. Also long seta present on each side near middle of frontal suture. Epicranium with two long setae dorsally near each ocellus; dorso-epicranial setae represented on each side by one long and two or more spine-like setae forming longitudinal row surrounded by a narrow paler area, which is not marbled; also some scattered pits, each with short spine-like seta, which are absent in young specimens. Antennae almost as long as cranium, four-segmented and in most specimens seen without any setae. Apical segment with one small round and five large oval sensory spots as well as terminal sensory spot with sensory pegs; penultimate segment also with sensory spot.

Labrum and clypeus

Labrum slightly more than half the length of cranium; divided by two clithra into one median and two lateral lobes. Median lobe with four dorsal setae and each lateral lobe with about four strong anterior setae and a long posterior one. Also two long paramedian setae, and in addition some short spine-like setae on posterior part of labrum. Clypeus about same length as labrum, with one long and one short seta on each side, as well as two long paramedian setae near posterior border. Postclypeus abundantly pitted.

Epipharynx (Fig. 21B). Corypha with four strong setae; haptomerum developed and strongly sclerotized in old specimens. Ten to twelve strong heli present, situated in a curved row and extended on each side as a curved row of strong setae that encircles pedium. Latter large, oval, its central area with strong setae, which are palus-like in front and more weakly developed posteriorly. Chaetoparia well developed on each side; each acroparia represented by fourteen to sixteen strong setae; acanthoparia with twelve to fourteen sickle-shaped setae, last two on each side very small and spine-like. Tormae asymmetrically

developed, dextortorma being largest. Epitormae almost obsolete. Crepis very weak, area enclosed (haptolachus) with conical sensory cone as well as elongate plate, which is part of posterior epitorma; fused tormae and anterior epitorma evident in some specimens examined. Two pairs of macrosensilla longitudinally arranged. Mesophoba forms continuation of setae encircling pedium and consisting of ten to fourteen fine setae on left side; on right side only about eight setae present of which inner four to five are stronger developed and spine-like.

Mandibles (Fig. 21I)

Mandibles long and narrow (length almost twice width) and somewhat longer than cranium. Dorsal carina rounded; scrobis weakly developed and almost obsolete in some specimens, only indicated by two depressions, each bearing short seta. Six to eight setae also present on each lateral face. About three small setae (xy) present laterad of molar area, those on left mandible in small depression. Stridulatory area present ventrally on both mandibles.

Cutting edges of both mandibles fairly narrow and pointed, that of left mandible with second tooth (t_1) rounded, scissorial notch not clearly demarcated in old specimens; third tooth (t_2) more acute, separated by deep notch from second. Fourth tooth (t_4) broad, situated in neck of mandible between cutting and molar areas. Second tooth (t_3) on scissorial area of right mandible fairly broad; scissorial notch obsolete in old specimens; third tooth (t_5) in neck, small and fairly rounded in some young specimens, more acute in older ones.

Molar area of left mandible clearly divided into proximal (m_2) and distal area (m_1); latter broad and forming round lobe-like tooth on ventral side; proximal area semi-circular posteriorly, with large brustia. Molar area of right mandible appears trilobed with deep notch between first (m_3) and second (m_5) and also between second and posterior tooth (m_4). Hind tooth broad posteriorly and divided by wide concavity into a large dorsal and smaller, more acute ventral tooth.

Maxillae (Fig. 21F)

Galea and lacinia fused but clearly divided by suture on dorsal side. Galea with single strong uncus, dorsal surface beset with about twenty-two setae, most of which are strong and spine-like, particularly those near uncus. Ventral side with strong spine just below uncus on mesal side and also about seven strong setae. Lacinia with two unci of which ventral one is smallest; also small spine (yy) at base of dorsal uncus. Mesal margin of mala beset with numerous strong setae, of which two are in form of stout spines, one on each side of the two unci. Stipes dorsally with medium-sized strong setae, particularly on lateral margin, and with about twelve stridulatory teeth. Ventrally with about eight strong setae distally and proximally only single strong seta present. Palpifer without any setae. Maxillary palp four-segmented; first segment small and only visible on exterior side; penultimate segment with one ventral and one lateral seta; apical segment con-

cal, with sensory pegs at extreme apex and sensory spot laterally. Labacoria sclerotized and beset with fine setae on both sides; alacardo with six to eight setae.

Labium

Distal sclerite of prementum not clearly divided into two lobes and with two paramedian setae. Proximal sclerite of prementum slightly convex, with two paramedian setae. Postmentum trapezoidal, with single short seta near each posterior corner; posterior half pitted in old specimens.

Hypopharynx (Fig. 21G). Glossa beset on each lateral third with numerous setae, those near anterior lateral corners continuing around palpal bases and almost encircling labial palpi. In some specimens, sides of median third of glossa sclerotized; area in between with three strong spines anteriorly; posteriorly on each side also with about five strong spines and some finer setae, as well as two median strong spines and about ten tubercles or sensory pegs. Transverse sclerite strongly developed, asymmetrical and with strong conical tooth on the right as well as weakly sclerotized area with three or four setae. Lateral sclerites strongly developed; left one with setae on its lateral and inner margin, right one with setae only on lateral margin.

Ninth and tenth abdominal sterna (Fig. 21H)

Boundary line between the two sterna hardly visible. Both sterna completely covered with medium-long, spine-like setae present both ventrally and laterally. *Raster*: campus occupied by tegillum; teges separated by two palidia, each consisting of eighteen to twenty-two short pali; septum thus formed wider posteriorly; same short palus-like setae flank each palidium. Anal opening transverse; lower anal lip small, not divided. Transverse row of short setae present on either side of anal slit, which is not visible when viewed from the ventral side.

Pupa (Fig. 21C)

Castaneous brown, first five abdominal segments yellow. However, a few days before imago emerges, it turns to a dark, almost black colour. Length 21–25 mm. Body almost devoid of setae. Abdominal terga 1–5 with a swelling on each side. Characteristic conical, median swelling present behind head on front margin of pronotum, clearly visible in figure.

BIOLOGY

The eggs of *Rhinocoeta cornuta* are laid during the summer and early autumn and the larval stage lasts throughout the winter. Mature larvae were already present in midwinter and those observed during the survey hibernated in the soil, pupating in the early summer. The larval stage therefore lasts at least 10 months or more. Observations made along the south coast showed that the larva at first feeds in the cow-pats and, as it grows bigger, constructs a tunnel in the soil below

the pats into which it retreats, only coming up to feed. At first it is bluish white in colour, but when fully grown it turns pinkish or slightly crimson and is then 40–45 mm long. Larvae collected in June constructed clay cells of about 25 mm diameter in October, in which they transformed to the prepupal stage. This stage is characterized by its dirty-white colour and wrinkled appearance, and lasts for at least 21 days, pupae appearing from about November to January and beetles emerging from early December to almost the middle of February. The pupal stage lasts for 25–27 days.

The newly-emerged beetle is light brown on the thorax, with yellow elytra and abdomen. After about 2 days the thorax becomes black and the elytra reddish brown and after about 3 days the beetle assumes its normal colour.

Temnorrhynchus retusus (Fabricius)

DESCRIPTION

Adult (Fig. 14E)

Light brownish red to dark brown in colour, shiny, to slightly shiny; elytra almost smooth, pronotum fringed with golden hairs, and with fairly large, shallow pits divided over middle of disc by a narrow glabrous band in most specimens seen; often with anterior median area of pronotum hollowed out or depressed. This beetle is easily recognized by the oval flat rugulose or reticulate-rugulose disc on the head, the edges of which are almost trenchant in some specimens. Length varying from 14 to 21 mm.

Widely distributed in South Africa and South West Africa (Endrödi 1960).

Larva (Fig. 22A)

Yellowish white in colour. Larva of *Temnorrhynchus retusus* rather similar to that of *T. coronatus* as described and figured by Oberholzer (1963). Thoracic and eighth to tenth abdominal terga with long slender setae, those of abdominal segments 1–7 also with short spine-like setae. All abdominal spiracles of about same size, that of prothorax slightly larger. Legs increasing in length from front to back, well developed; tibiae of the first two pairs somewhat tapering towards their apices, those of the hind pairs convex below, not straight (Fig. 22D). Claws of first two pairs (Fig. 22C) long, somewhat compressed or flattened dorsoventrally over their distal two-thirds and each with single broad posterior seta near base, and longer more slender one anteriorly some distance from base, at beginning of compressed portion. Claws of hind pair (Fig. 22D) short, only about half the length of those of second pair and each with somewhat sinuate lateral margins (when viewed from above or below), with single broad posterior seta near base and somewhat longer seta some distance from apex, as shown in Figure 22E.

According to Crowson (1967) the terga of the ninth and tenth abdominal segments of the subfamily Dynastinae are completely fused as in the case of the Cetoniinae. However, in this species the terga are fairly distinct, which agrees with the drawing by Oberholzer of the *T. coronatus* larva.

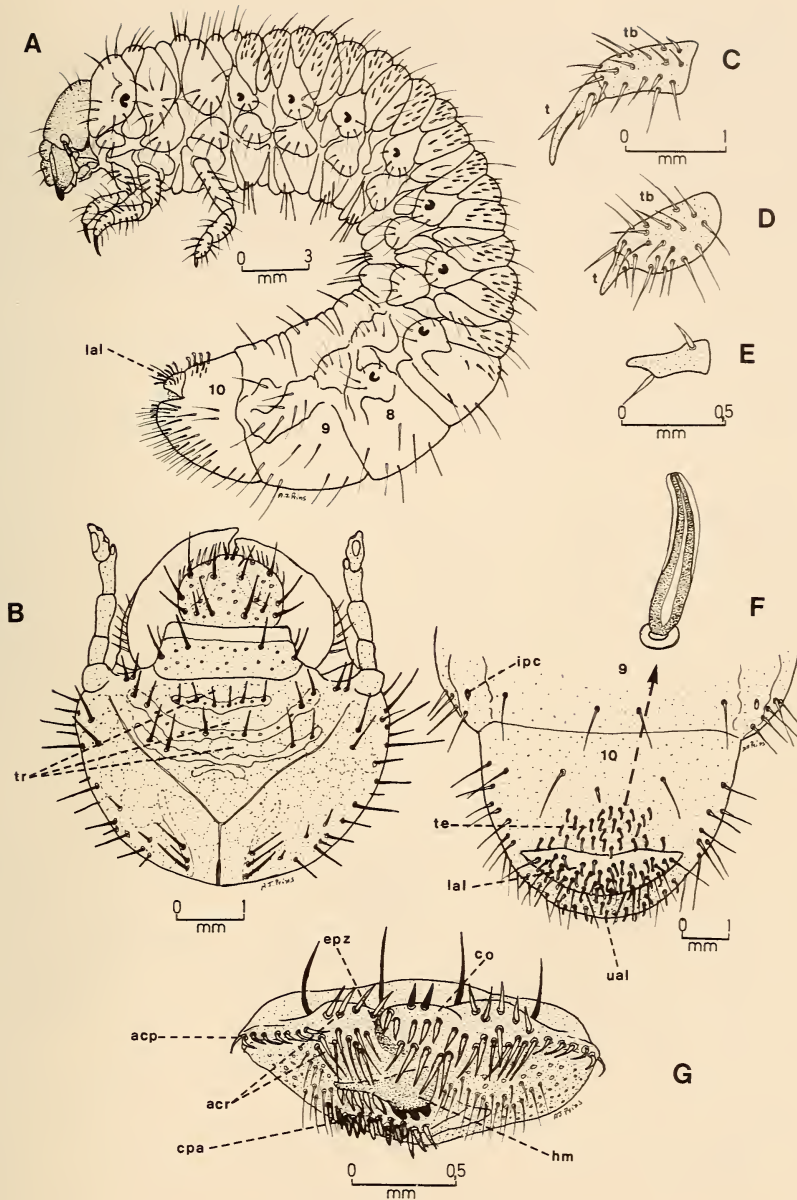


Fig. 22. Scarabaeidae. *Temnorhynchus retusus* larva. A. Left lateral view. B. Head, dorsal view. C. Tibia and tarsus of mesothoracic leg, posterior view. D. Tibia and tarsus of metathoracic leg, posterior view. E. Claw of metathoracic leg, seen from below. F. Apical abdominal segments, ventral view. G. Anterior margin of labrum, viewed directly from the front.

Head (Fig. 22B)

Slightly less than one-third wider than long, sides and hind margin very convex; reddish to brownish in colour, almost superficially rugoso-reticulate, forming three inconspicuous ridges on frons, separated by areas of lighter sclerotization; first transverse area just behind frontoclypeal suture fairly deeply excavated in some specimens and bearing about six anterior frontal setae. Second light-coloured area bears two exterior frontal setae on each side as well as two paramedian setae. In this species four posterior frontal setae present behind third transverse ridge; otherwise chaetotaxy as illustrated. Frontal and coronal sutures faintly visible.

Four-segmented antennae about half as long as width of head; first, third and apical segments of about equal length, second segment longest. Apical segment with large dorsal oval sensory spot as well as two smaller spots on ventral side; penultimate segment also with oval sensory spot on cone-shaped apical projection.

Labrum and clypeus

Labrum pitted, about one-third wider than long, narrower and about one-third longer than clypeus; its anterior and lateral margins convex. Anterior transverse row of four setae present, one of which is situated on each lateral margin; posterior row of about eight setae as illustrated. Also two spine-like setae present in middle of anterior margin. Clypeus nearly two-thirds wider than long, its anterior margin slightly concave. Postclypeus also pitted with transverse row of four setae, one of which is situated on each lateral margin; also a shorter lateral seta near anterior margin of postclypeus.

Epipharynx (Figs 22G, 23A). *Corypha* fairly well indicated, with about five strong setae on its ventral margin and about seven bordering the dorsal edge. *Epizygum* fairly discernible in most specimens seen. *Haptomerum* strongly sclerotized and with about seven sensilla and three broad teeth or *heli* flanked on right side by about eight strong dentiform setae of the *chaetoparia*. Latter beset with strong setae on both sides, the setae diminishing in size towards the *plegmata*, forming pitted *gymnopariae*. *Acropariae* each with about fifteen long setae of which four to five are situated in a dorsal position. Each *acanthoparia* with ten to twelve sickle-shaped setae; each seta with indistinct *plegma*. *Pedium* well indicated, traversed in middle by narrow anterior *epitorma*. Both *dexio-* and *laeotorma* as narrow strongly sclerotized plates; *laeotorma* with small almost conical *pternotorma*, which is rather similar to that of *Rhinocoeta cornuta*. *Mesophoba* on each side as row of slender setae. *Crepis* indicated by fold, *haptolachus* includes an almost triangular sensory plate, a sensory cone and two *macrosensilla* on each side.

Mandibles (Fig. 23E-F)

Fairly long, about one-third longer than wide. Dorsal carinae rounded and scrobis with one medium-long, broad distal seta and longitudinal row of five small

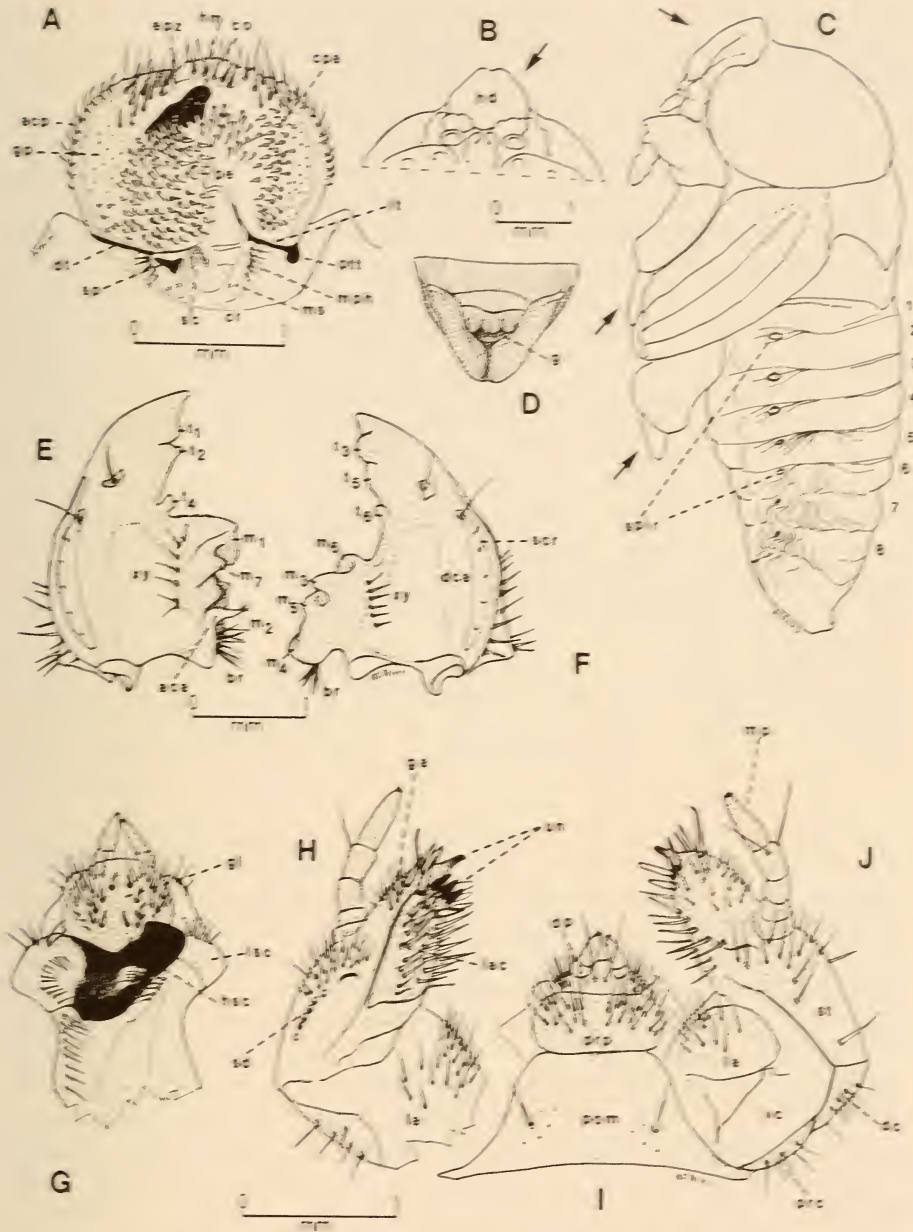


Fig. 23. Scarabaeidae. *Temnorhynchus renatus*. A. Epopharynx of larva. B-D. Pupa. B. Head, ventral view. C. Left lateral view. D. Apex of abdomen, ventral view showing developing genital capsule. E-J. Larva. E. Left mandible, dorsal view. F. Right mandible, dorsal view. G. Hypopharynx. H. Left maxilla, dorsal view. I. Labium, ventral view. J. Left maxilla, ventral view.

pits, each with short seta. Lateral areas with ten to fourteen setae; also about seven setae at base on ventral carina. Medium-long seta present in depression on neck of scissorial area, about half-way between seta on scrobis and third tooth (t_2 and t_3).

Cutting edge of left mandible with first and second tooth (t_1) united as broad blade, with deep notch between second and third tooth (t_2). Small almost truncate tooth (t_4) present at junction of molar and cutting edge on left mandible, absent in right one but represented by distinct tooth (t_6), present about half-way between rounded third tooth (t_3) and molar area. Second (t_3) and third tooth (t_5) on right mandible rounded, in most specimens rather indistinct, in some almost obsolete.

Molar area on right mandible smaller than that on left, with upper strong tooth (m_3) forming transverse ridge in front of which is fairly distinct ventral tooth (m_6). Second molar tooth (m_5) small, also forming ridge, similar to that of m_3 and strongly developed on ventral side. Posterior tooth (m_4) almost as broad lobe, bearing brustia. Molar area of left mandible with broad lobe-like transverse tooth (m_1) followed by second conical tooth (m_7). Proximal molar area (m_2) in this case broad, rounded posteriorly with almost semi-circular row of about twenty-two strong setae, and forming a short broad anteroventral tooth as well as a broad, conical anterodorsal tooth, behind which is almost triangular acia with four short apical setae. Also row of about seven dorsomolar setae present on inner margin of both molar areas.

Ventrally each mandible with broad, oval stridulatory area with small pit carrying two setae, about half-way between it and molar area (this pit with setae also present in most other scarab larvae).

Maxillae (Fig. 23H, J)

Galea and lacinia united, but clearly indicated by dividing suture on dorsal side, ventrally only by S-shaped sclerotized line. Galea with single long acute uncus at apex, dorsally with three strong setae below uncus and longitudinal row of three to four more slender setae along dividing suture, as well as some smaller slender setae; ventrally also with three strong setae below uncus as well as some more slender setae as indicated in figure; strong palus-like seta present on base of uncus on lateral margin. Lacinia with three conical unci, somewhat smaller than that of galea, bordered by strong broad setae, its mesal margin fairly densely covered with strong setae. Stipes dorsally with about six truncate stridulatory teeth and distad of these obliquely placed rounded and wider stridulatory tubercle; ventrally and dorsally with fine slender setae, some also on lateral margin and single proximal one close to border of disticardo. Palpifer clearly demarcated, without any setae and bearing four-segmented palp of which first segment is shortest; third segment somewhat longer than second and with single ventral and lateral seta; fourth segment longest, about as long as second and third together, and with some sensory cones at apex. Both disti- and proxicardo with some setae, ventrocardo without setae. Labacoria fairly convex ventrally and beset with slender setae on both sides.

Labium (Fig. 23I)

Postmentum slightly wider than long, with single short seta near each posterior corner; proximal sclerite of prementum wider than long, convex, with slender setae; distal sclerite with two long paramedian setae near palpal bases, and some slender setae on each side. Two-segmented palpi with apical segment almost twice as long as first and with sensory pegs at apex.

Hypopharynx (Fig. 23G). Glossa convex, its central disc with short spine-like setae, arranged almost in a circle in some specimens; on each side with slender setae. Hypopharyngeal sclerite strongly sclerotized, asymmetrical, with strong tooth with small depression bearing brush of fine setae on right side; more weakly sclerotized on left. Lateral sclerites less sclerotized, lateral margins acute or pointed in middle, on left with some setae distally, also curved row of fine setae down its middle and along posterior lateral margin; on right side also with some fine setae distally near base of transverse tooth and row near basal border of latter.

Ninth and tenth abdominal sterna (Fig. 22F)

Dividing line between two segments clearly indicated. Ninth sternum with transverse row of four setae near posterior border, two of which are more or less paramedian setae, situated fairly close together. Tenth sternum also with four setae, the median ones far apart. *Raster*: teges with about thirty-five to forty hamate setae; palidium absent; also thirty-five to forty hamate setae on lower anal lip and some on upper anal lip. Internal sclerotized pouch on venter of ninth abdominal sternum similar to that described by Oberholzer (1963) for *T. coronatus*.

Pupa (Fig. 23B–D)

Castaneous brown and rather similar in colour to that of *Rhinocoeta cornuta*. Easily recognized by flat disc on the head as in adult. Hind margin of pronotum almost straight as in *R. cornuta*. Spiracles also similar to those of both the latter and *Pachnoda sinuata*, first four pairs large and oval, first pair covered by wing sheaths; fifth to eighth pair smaller and inconspicuous. Pupa of this species lacks the five pairs of dorsal abdominal tubercles or swellings present in the case of *R. cornuta* and *P. sinuata*. Legs with tarsal sheaths much shorter than in other two species. Developing genital capsule similar to that of *P. sinuata*, but three swellings much more prominent than in latter. Length 23–25 mm.

BIOLOGY

Larvae of *Temnorhynchus retusus* were found in sandy soils in the Cape Peninsula throughout the year, feeding on the roots of grasses and other garden plants. Pupae formed in clay cells were observed during November and the beetles emerged during December. Newly-emerged beetles are brownish-red to reddish, but assume their normal coloration within a day or two.

Trox rhyparoides Harold

DESCRIPTION

Adult (Fig. 24A)

Peringuey (1901) and Scholtz (1980) give a good description of *Trox rhyparoides*. Blackish, but usually covered with soil which gives it a greyish appearance. Head and thorax closely pitted. Clypeus triangular and pointed in front. Prothorax raised in middle; this raised area wider in front than behind, with three impressions in middle and wider one behind; disc on each side behind this raised area with median carina. Head also with strong transverse ridge intersected in middle by blunt carina which ends at apex of pointed clypeus. Elytra with about eight strong costae, area between them with two rows of foveae with tiny, shiny tubercles in between. Head and prothorax fringed with spoon-shaped hairs.

According to Scholtz (1980) the absence of setal tufts and fringes on the pronotum and elytra and the distinct costal ridges make *T. rhyparoides* a very distinctive species. In specimens examined the lateral margins of elytra have only very small spine-like setae and the fosciculate tubercles, present in other species of *Trox* collected during the surveys, are absent. Length 7,1–8,5 mm.

Widely distributed in the Republic of South Africa and Lesotho, and also present on St. Helena (Scholtz 1980).

Larva (Fig. 24D)

Baker (1968) gives a general description of the larvae of the genus *Trox*. In *T. rhyparoides* mature larvae are almost white with golden-brown head, which is somewhat piceous on the sides above eyes. In young stages, head is pale piceous red. Abdominal segments 1–8 divided into three annulets, those of segments 1–6 and first two annulets of segment 7 bearing short, spine-like setae as well as long hairs. Eighth segment devoid of spines. Prothoracic shield fairly clearly indicated, its front margin straight. Spiracles (Fig. 24M) biforous; under high magnification three sclerotized struts clearly visible, with middle one somewhat stronger than other two. According to Hinton (1967) the trogids have elateroid spiracles which evolved from the primitive type of spiracle in which the orifice of the spiracle is not sufficiently blocked by cuticular struts to prevent the withdrawal through it at ecdysis of the old spiracle and tracheae. Legs well developed and covered with long hairs; claws (Fig. 24E) acute, simple, each bearing two medium-long setae near base.

Small larvae measuring 5,5 mm in length are very similar to full-grown specimens, but differ from the latter in the smaller number of annulets which have spines; in specimens examined only one annulet on each of abdominal segments 1–7 contained spines.

Head (Fig. 24G)

Wider than long; frontoclypeal suture obsolete in middle and forming wide U-shaped depression with four hairless pits. Frons deeply pitted; four of pits on

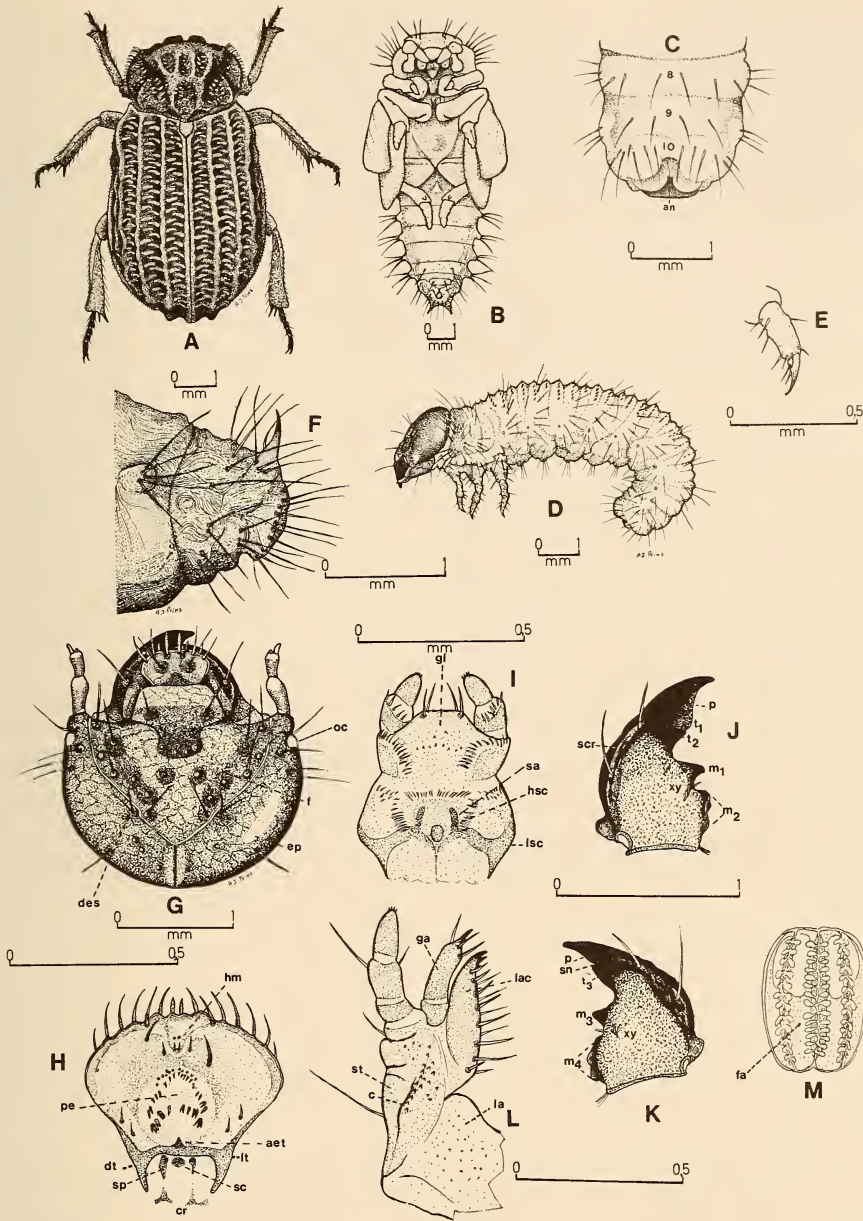


Fig. 24. Scarabaeidae. *Trox rhyparoides*. A. Adult. B. Pupa, ventral view. C-E. Larva. C. Apical abdominal segments, ventral view. D. Larva, left lateral view. E. Right mesothoracic tibia. F. Apex of pupa, left lateral view. G-M. Larva. G. Head, dorsal view. H. Epipharynx. I. Hypopharynx. J. Left mandible, dorsal view. K. Right mandible, dorsal view. L. Left maxilla, dorsal view. M. Biforous abdominal spiracle (highly magnified).

each side with long seta each. Each side of epicranium with four dorsal setae, of which dorso-epicranial one is often double; some pits also hairless. Ocelli present and fairly prominent behind antennal bases. Antennae much shorter than cranium, three-segmented, third segment very small.

In young specimens, measuring 3–3.5 mm, posterior epicranial (exterior dorso-epicranial) setae are absent; otherwise head is similar to that of mature specimens.

Labrum and clypeus

Labrum about as long as clypeus. Its anterior margin not clearly divided by weakly developed clithra; dorsally with six long setae along front margin, as well as two paramedian setae on central disc. Postclypeus with only two setae.

Epipharynx (Fig. 24H). Plegmata and proplegmata absent. Corypha with four strong setae. Acanthoparia with five to six almost sickle-shaped setae. Acroparia represented by three asymmetrically arranged setae on each side of haptomeral area; two long setae (close together) present on right side near anterior border; on left, however, one long seta situated near pedium and one near anterior border; small seta posteriorly on each side of haptomeral area; these setae may be longer in older specimens. Haptomerum almost conical, fairly well sclerotized in old specimens and without teeth in specimens examined, except for two small setae proximally and two sensilla. Pedium raised and convex, central area with stout hairs or groups of spines, particularly on proximal area; distally with short spines and curved row of twelve to fourteen sensilla anterior to these. Tormae (dt and lt) symmetrically developed with short anterior epitorma. Chaetoparia represented by two setae proximally along anterior arms of tormae. Crepis represented by two small sclerotized areas; sclerotization more complete in older specimens; two sclerotized or sensory plates and sensory cone also present.

Mandibles (Fig. 24J–K)

Slightly more than half the length of cranium, both mandibles slightly longer than wide. Dark golden brown in colour with molar, scissorial and lateral edges black. Neck of both mandibles short; scrobis and dorsal carina well developed; scrobis with one long proximal and shorter distal seta. Stridulatory area absent on both mandibles, but each with small brustia.

Left mandible with broad blade-like cutting edge; scissorial notch indicated in most specimens; third tooth (t_2) small and acute in some specimens. Cutting edge of right mandible also fairly broad, with two distinct teeth; second tooth (t_3) broad, scissorial notch well marked in most specimens.

Molar areas of both mandibles divided into two teeth, of which distal tooth (m_1 and m_3) is conical and situated almost half-way between last scissorial tooth (t_2 or t_3) and proximal molar area (m_2 or m_4). Tiny longitudinal groove with fine dorsomolar setae present on both mandibles.

Maxillae (Fig. 24L)

Galea and lacinia free for most of their length. Galea bearing single strong uncus; lacinia with two strong unci and third smaller tooth on ventral side. Galea with five strong setae around uncus of which two are situated ventrally. Lacinia with about thirteen strong setae on mesal margin, arranged more or less in two rows. Stipes with only two long setae, one on ventral side near cardo and one on palpifer; dorsally without setae, but with strong ridge (c) bearing about twenty stridulatory teeth. Cardo with only one short seta on disticardo; labacoria beset with minute spinules. Maxillary palp four-segmented, with two setae on ventral side of penultimate segment and one on ventral side of basal segment. Palpifer not clearly demarcated on dorsal side and bearing few small stridulatory teeth.

Labium

Submentum trapezoidal, with single seta on each side near lateral margin. Mentum convex, with two long setae. Distal sclerite of prementum not divided into lobes but with two setae near anterior margin, one on each side of palpiger. Two setae also present posteriorly near border of proximal sclerite of prementum. Palpiger also with some small spine-like setae on external border.

Hypopharynx (Fig. 24I). Distal region of glossa with only four setae and some minute spines or cones, which are in some specimens almost semi-circularly arranged; also with semi-circular row of fine hairs on each side. Hypopharyngeal sclerite weakly developed and with row of fine hairs in front and on each side; in older specimens hypopharyngeal sclerite more strongly developed, particularly its two anterior arms (subapotormae). Same applies to lateral sclerite (subtormae).

Ninth and tenth abdominal sterna (Fig. 24C)

Dividing line between these segments lacking; ninth sternum with transverse row of about eight setae, tenth with transverse row of about twelve. *Raster* absent. Upper anal lip small, lower anal lip almost semi-circular and divided by slit into two halves. The feebly trilobed anal area suggests relationship to the stag-beetles, Lucanidae (Hayes 1929).

Pupa (Fig. 24B)

Newly formed pupa yellowish white and 8–9 mm long. Anterior and lateral borders of pronotum as well as anterior part of head setose. Meso- and metathorax dorsomedially bearing two closely approximated tubercles, each one with about four setae. Six fleshy protuberances also present laterally on abdomen, each bearing five to seven long setae. Apex of abdomen with long setae and two fairly long hooks pointing upwards (Fig. 24F).

BIOLOGY

Trox rhyparoides beetles were found in large numbers under decaying animals around Cape Town from March to November. They feed on bits and pieces of flesh left on the skeletons as well as on loose hairs scattered on the ground

around the carcasses. Young larvae occurred during May and again during October and pupae were collected around the middle of August and also at the end of October. According to available information, the larval period lasts for about 6 weeks and the pupal stage 10–14 days.

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REFERENCES

- ANDERSON, W. H. 1936. A comparative study of the labium of Coleopterous larvae. *Smithson. Misc. Collns* **95** (13): 1–29.
- ANDRES, A. 1931. Catalogue of the Egyptian Tenebrionidae. *Bull. ent. Soc. Egypt* **15**: 74–125.
- ARNETT, R. H. 1963. *The beetles of the United States*. Washington: Catholic University of America Press.
- BAKER, C. W. 1968. Larval taxonomy of the Trogidae in North America with notes on biologies and life-histories (Coleoptera: Scarabaeidae). *Bull. U.S. natn. Mus.* **279**: 1–79.
- BARKÉ, H. E. & DAVIS, R. 1969. Notes on the biology of the lesser meal-worm, *Alphitobius diaperinus* (Coleoptera: Tenebrionidae). *J. Georgia ent. Soc.* **4**: 46–50.
- BEDFORD, E. C. G., DE WET, P. & ODENDAAL, J. S. 1974. Spotted maize beetle, *Astylus atromaculatus* Blanch., Dasytidae. In: MATTHEE, J. J. ed. Pests of graminaceous crops in South Africa. *Entomology Mem. Dep. agric. tech. Servs Repub. S. Afr.* **40**: 1–23.
- BEDWELL, E. C. 1931. Dermestid beetles attacking wood. *Entomologist's mon. Mag.* **67**: 93–94.
- BÖVING, A. G. & CRAIGHEAD, F. C. 1931. An illustrated synopsis of the principal larval forms of the order Coleoptera. *Entomologica am.* **11**: 1–351.
- BRITTON, E. B. 1970. Coleoptera. In: WATERHOUSE, D. F. ed. *The insects of Australia*: 495–621. Victoria: Melbourne University Press.
- CORNWELL, P. B. 1973. *Pest control in buildings*. London: Hutchinson.
- CORPORAAL, J. B. 1950. Cleridae. *Coleoptm Cat.* **23**: 1–373.
- COTTON, R. T. 1941. *Insect pests of stored grain and grain products: identification, habits and methods of control*. Minneapolis, Minn.: Burges.
- CROWSON, R. A. 1952. The classification of the families of British Coleoptera. *Entomologist's mon. Mag.* **88**: 64–71.
- CROWSON, R. A. 1964. A revision of the classification of Cleroidea (Coleoptera), with descriptions of two new genera of Peltidae and of several new larval types. *Trans. R. ent. Soc. Lond.* **116**: 275–327.
- CROWSON, R. A. 1967. *The natural classification of the Coleoptera*. Hampton (England): Classey.
- CSIKI, E. 1934. Curculionidae: subfam. Cleoninae. *Coleoptm Cat.* **134**: 1–152.
- DELKESKAMP, K. 1977. Cantharidae. *Coleoptm Cat. (Suppl.)* **165**: 1–485.
- DICK, J. 1937. Oviposition in certain Coleoptera. *Ann. appl. Biol.* **24**: 762–796.
- DONALDSON, J. M. I. 1979. Laboratory rearing technique for *Pachnoda sinuata flaviventris* (Coleoptera: Scarabaeidae) and for other cetoniid larvae. *J. ent. Soc. sth. Afr.* **42**: 137–142.
- DYBAS, H. S. 1976. The larval characters of featherwing and limulodid beetles and their family relationships in the Staphylinioidea (Coleoptera: Ptiliidae and Limulodidae). *Fieldiana Zool.* **70**: 29–78.
- EIDSON, C. S., SCHMITTLE, S. C., LAL, J. B. & GOODE, R. B. 1965. The role of the darkling beetle, *Alphitobius diaperinus*, in the transmission of acute leukosis in chickens. *Poult. Sci.* **44**: 1366–1367.
- ENDRÖDI, S. 1960. Coleoptera, Melolonthidae subfamily Dynastinae. *S. Afr. anim. Life* **7**: 34–82.

- FAUVEL, A. 1889. Liste des coléoptères communes à l'Europe et à l'Amérique du Nord. *Revue Ent.* **8**: 92-174.
- FERRERA, M. C. 1967. Aditamento ao catalogo, dos escarabideos da regias etiopica. Tribos Canthonini e Alloscelini. *Revta Ent. Mocamb.* **10**: 1-778.
- FERRERA, M. C. 1978. The genus *Onitis* F. of Africa south of the Sahara (Scarabaeidae, Coleoptera). *Mem. natn. Mus. Bloemfontein* **10**: 1-410.
- FISHER, R. C. 1944. A note on *Paratillus carus* Newman (Coleoptera: Cleridae) and records of its occurrence in Great Britain. *Entomologist's mon. Mag.* **80**: 132-134.
- FROGGATT, M. W. 1927. *Forest insects and timber borers*. Sydney: Govt. Printer.
- HAYES, W. P. 1929. Morphology, taxonomy, and biology of larval Scarabaeoidea. *Illinois biol. Monogr.* **12**: 1-119.
- HEEGER, E. 1848. Beiträge zur Naturgeschichte der Kerfe. *Oken's Isis* **1848**: 974-979.
- HETSCHKO, A. 1930a. Colydiidae. *Coleoptm Cat.* **107**: 1-124.
- HETSCHKO, A. 1930b. Cucujidae, Thorictidae (Suppl.), Cossyphodidae (Suppl.) *Coleoptm Cat.* **109**: 1-122.
- HINTON, H. E. 1941. The Ptinidae of economic importance. *Bull. ent. Res.* **31**: 331-381.
- HINTON, H. E. 1943. *Stethomezium squamosum* gen. et sp. n. infesting stored food in Britain, with notes on a South African ptinid not previously recorded in stored products (Coleoptera). *Proc. R. ent. Soc. Lond. (B)* **12**: 54.
- HINTON, H. E. 1945. *A monograph of the beetles associated with stored products I*. London: The Trustees, British Museum (Nat. Hist.); Norwich: Jarrold & Sons.
- HINTON, H. E. 1948. A synopsis of the genus *Tribolium* Macleay with some remarks on the evolution of its species groups (Coleoptera: Tenebrionidae). *Bull. ent. Res.* **39**: 13-55.
- HINTON, H. E. 1967. Structure and ecdysial process of the larval spiracles of the Scarabaeidae, with special reference to those of *Lepidoderma*. *Aust. J. Zool.* **15**: 947-953.
- HOPE, F. W. 1834. Notice of several species of insects found in the heads of Egyptian mummies. *Trans. R. ent. Soc. Lond.* **1**: XI-XIII.
- JACK, R. W. 1918. Notes on the larvae, etc., of some Rhodesian Tenebrionidae. *S. Afr. J. nat. Hist.* **1**: 84-98.
- JANSENS, A. 1953. Oniticellini (Coleoptera Lamellicornia). *Explor. Parc natn. Upemba Miss. G. F. de Witte* **11**: 1-118.
- JERATH, M. L. 1966. Larvae of two species of the genus *Heteronychus* from Nigeria (Dynastinae: Scarabaeidae: Coleoptera). *Coleopts Bull.* **20**: 113-116.
- KOCH, C. 1953. The Tenebrionidae of Southern Africa III: Tenebrionidae from a nest of *Tatera*. *Revue Zool. Bot. afr.* **57**: 1-30.
- KOCH, C. 1958. Preliminary notes on coleopterological aspects of the arrow poison of the Bushmen. *Pamph. S. Afr. biol. Soc.* **20**: 49-54.
- LAING, F. 1928. A note on two parasites of *Lyctus parallelopedus* Mel. *The Entomologist* **61**: 163-164.
- LE PELLEY, R. H. & GODDARD, W. H. 1952. On the control by insecticides of *Heteronychus consimilis* Kolbe (Dynastinae), a serious pest of wheat in Kenya. *Bull. ent. Res.* **43**: 402-406.
- MORISON, G. D. 1925. The Khapra beetle (*Trogoderma granarium* Everts). *Proc. R. phys. Soc. Edinb.* **21**: 10-13.
- OBERHOLZER, J. J. 1958. A description of the third stage larva of *Onitis caffer* Boh. (Copridae: Coleoptera) with notes on its biology. *S. Afr. J. agric. Sci.* **1**: 415-422.
- OBERHOLZER, J. J. 1959. A morphological study of some South African lamellicorn larvae. 1. Description of the third instar larvae. *S. Afr. J. agric. Sci.* **2**: 41-74.
- OBERHOLZER, J. J. 1963. Description of the larva of *Temnorhynchus coronatus* F. (Dynastidae: Coleoptera). *S. Afr. J. agric. Sci.* **6**: 85-90.
- PERINGUEY, L. 1901. Descriptive catalogue of the Coleoptera of South Africa. *Trans. S. Afr. phil. Soc.* **12**: 1-560.
- PERINGUEY, L. 1907. Descriptive catalogue of the Coleoptera of South Africa. *Trans. S. Afr. phil. Soc.* **13**: 294-546.
- PETERSON, A. 1967. *Larvae of insects. Part 2. Coleoptera, Diptera, Neuroptera, Siphonaptera, Mecoptera, Trichoptera*. Columbus, Ohio: Edwards Brothers Inc. (Lithographed.)
- PRINS, A. J. 1965. Notes on the biology and morphology of the wattle chafers *Monochelus calcaratus* Burm. (Melolonthidae), *Hypopholis sommeri* Burm. (Melolonthidae), and *Adoretus ictericus* Burm. (Rutelidae) with some references to natural enemies (Coleoptera: Lamellicornia). *Entomology Mem. Dep. agric. tech. Servs Repub. S. Afr.* **9**: 1-55.

- REES, B. E. 1943. Classification of the Dermestidae (larder, hide and carpet beetles) based on larval characters, with a key to the North American genera. *Misc. Publs U.S. Dep. Agric.* **511**: 1-18.
- ROSE, D. J. W. 1964. A new surface beetle *Herpsciscus somneri* Sol., a pest of maize. *Rhodesia agric. J.* **61**: 29.
- SCHEIN, H. 1954. Über *Coenochilus* (Coleoptera, Cetoniidae). Eine Revision der afrikanischen Arten mit einer Bestimmungstabelle und ein Nachtrag zu meiner Revision der asiatischen Arten. *Ent. Arb. Mus. Georg Frey* **5**: 271-325.
- SCHEIN, H. 1960. Coleoptera (Scarabaeidae): Cetoniinae und Trichiinae. *S. Afr. Anim. Life* **7**: 83-112.
- SCHMIDT, A. 1910. Coleoptera Lamellicornia. *Gen. Insect.* **110**: 1-155.
- SCHOLTZ, C. H. 1980. Monograph of the genus *Trox* F. (Coleoptera: Trogidae) of Sub-Saharan Africa. *Cimbebasia Mem.* **4**: 1-104.
- SCOTT, H. 1919. Notes on the biology of *Necrobia ruficollis* Fabr. (Coleoptera: Cleridae). *Ann. appl. Biol.* **6**: 101-115.
- SHAW, E. M., WOOLLEY, P. L. & RAE, F. A. 1963. Bushman arrow poison. *Cimbebasia* **7**: 1-41.
- SIMMONS, P. & ELLINGTON, G. W. 1925. The ham beetle *Necrobia rufipes* De Geer. *J. agric. Res.* **30**: 845-863.
- SKAIFE, S. H. 1953. *African insect life*. Cape Town: Longmans Green.
- SMIT, B. 1964. *Insects in southern Africa: how to control them*. Cape Town: Oxford University Press.
- SMITH, K. G. V. 1973. *Insects and other arthropods of medical importance*. London: The Trustees, British Museum (Nat. Hist.).
- STRONG, L. 1981. Dermestids: an embalmer's dilemma. *Antenna* **5**: 136-139.
- TRIBE, G. D. 1978. Ball-rolling dung beetles. *Afr. wild Life* **32**: 32-33.
- VAN EMDEN, F. I. 1948. A *Trox* larva feeding on locust eggs in Somalia. *Proc. R. ent. Soc. Lond.* (B) **17**: 145-148.
- VOSS, E. 1973. Coleoptera Curculionidae partim. *S. Afr. anim. Life* **15**: 395-479.
- WATT, J. C. 1974. A revised subfamily classification of Tenebrionidae (Coleoptera). *N.Z. J. Zool.* **1**: 381-452.
- WINKLER, J. R. 1960. Coleoptera Cleridae. *S. Afr. anim. Life* **7**: 127-162.
- WITTMER, W. 1960. Coleoptera: Cantharidae, Malachiidae and Dasytidae. *S. Afr. anim. Life* **7**: 113-127.

ABBREVIATIONS

ac	alacardo
aca	acia
acp	acanthoparia
acr	acroparia
aet	anterior epitorma
an	anus
ant	antenna
br	brustia
c; carc	carina; ridge
car	cardo
cl	clithrum
co	corypha
cos	epicranial suture; coronal suture
cpa	chaetoparia
cpp	caudal support projection
cr	crepis
csc	convex sclerite of cardo
cx	coxa

dc	disticardo
dca	dorsal carina
des	dorso-epicranial setae
dp	distal sclerite of prementum
dph	dexiophoba
dt	dexiotorma
e	compound eye
eal	exterior anal lobe
eds	exterior dorso-epicranial setae
ep	epicranium
eps	epipharyngeal sclerome
epz	epizygum, zygum
f	frons
fa	finger-shaped air-tube of biforous spiracle
fe	femur
g	developing genital capsule
ga	galea
gl	glossa
gla	protrusible gland
gp	gymnoparia
gt	gin trap
gu	gula
hd	head
hm	haptomerum
hps; hsc	hypopharyngeal sclerome; hypopharyngeal sclerite
ial	interior anal lobe
ipc	opening of internal sclerotized pouch
k	claw; tarsungulus
jxs	juxtastipes
l	ligula
la	labacoria
lab	labium
labr	labrum
lac	lacinia
lal	lower anal lip
lls	lateral lobe setae
lm	prosthema
lp	labial palp
lph	laeophoba
ls	labial stipes
lsc	lateral sclerite
lt	laeotorma
m	mentum
m ₁₋₆	molar areas
ma	mala
md	mandible
m _{la}	superlinguae; maxillulae
mls	median lobe setae
mp	maxillary palp
mph	mesophoba
ms	macrosensillum
mx	maxilla
oc	ocellus
of	occipital foramen
on	oncyli
p	scissorial area
pal	palidium
pam	paramentum
pc	postclypeus
pca	precardo
pe	pedium

pen	penicillus
pet	posterior epitorma
pf	palpifer
pfg	palpiger
pm	prementum
pom	postmentum
prc	proxicardo
prp	proximal sclerite of prementum
pth	protophoba
ptp	pteronotal support projection
ptt	pternotorma
ret	retinaculum
s	spur
sa	subapotorma
sc	sensory cone
sca	subcardo
scr	scrobis
sd	stridulatory teeth
seg; sg	sensory spot
sens	sensory punctures
sep	septum
sh	straining hairs
sj	sensory appendix; supplementary joints of antennae
sm	submentum
sn	scissorial notch
snc	subnasal sclerite
sp	sensory plate
spir	spiracle
st	maxillary stipes
suc	subcardo
t	tarsungulus
t ₁₋₆	mandibular teeth; hypopharyngeal teeth
tb	tibia
te	teges
tgl	tegillum
to	torma
tp	dorsal tergal support projection
tr	transverse ridge
tu	tubercle
ual	upper anal lip
un	uncus
ur	urogomphus
vc	ventrocardo
x	short and long setae on labrum of scarab larva
xy	dorsomolar setae
y	narrow sclerotized plate
yy	spine at base of uncus
z	tuft of hairs
zz	median hairs near labral apex